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ON THE BIONOMICS AND LIFE-HISTORY OF *CONIOPTERYX PUSANA* WITHYCOMBE CONIOPTERYGIDAE (NEUROPTERA).

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INTRODUCTION

Coniopterygidae constitute a small but well defined family of the Sub-order *Planipennia* of the order *Neuroptera.* The insects belonging to this family are very minute but from an economic point of view they are very important in that both as larvae and imagines they are predacious upon Rhynchota, mites, etc. The biology of hardly any Indian species of this interesting family has been studied in detail. In the following pages, the bionomics and life-history of *Coniopteryx pusana* Withycombe, a predator on the eggs of *Pyrilla,* one of the most serious pests of sugarcane all over India, are described.

BIONOMICS

The predator (Fig. 10) is first seen in the field in Pusa from the last week of July when it appears in small numbers. The adults were seen feeding on the honey-dew produced by the *Pyrilla* and during August and September when the white-fly of sugarcane was also feeding on the cane leaves and producing honey-dew, the predator was seen amongst the white-flies also. The adult insect is pale brown in colour and the body and wings are covered with white, waxy powder. From August onwards, on a careful examination of the egg masses of *Pyrilla* that are on the underside of the cane leaves, minute orange pinkish top-shaped larvae can be seen feeding with their spear-like mouth-parts on the egg contents of *Pyrilla.* It is the full fed or the third instar larvae (Fig. 5) that are most commonly met with. It is possible that owing to the extremely small size of the first instar larvae and also their very light pink colour, they are not easily visible to the naked eye in the field. On the underside of the sugarcane leaves here and there in between several egg masses may also be seen small round double silken cocoons (Fig. 8). Some of these cocoons may be seen cut anteriorly (Fig. 9) showing that the adults have emerged. It is also not unusual to find the larvae spinning the silken cocoon from silk emitted from the anal end, the movements being seen clearly specially where only the first layer of the cocoon has been formed.

LIFE-HISTORY

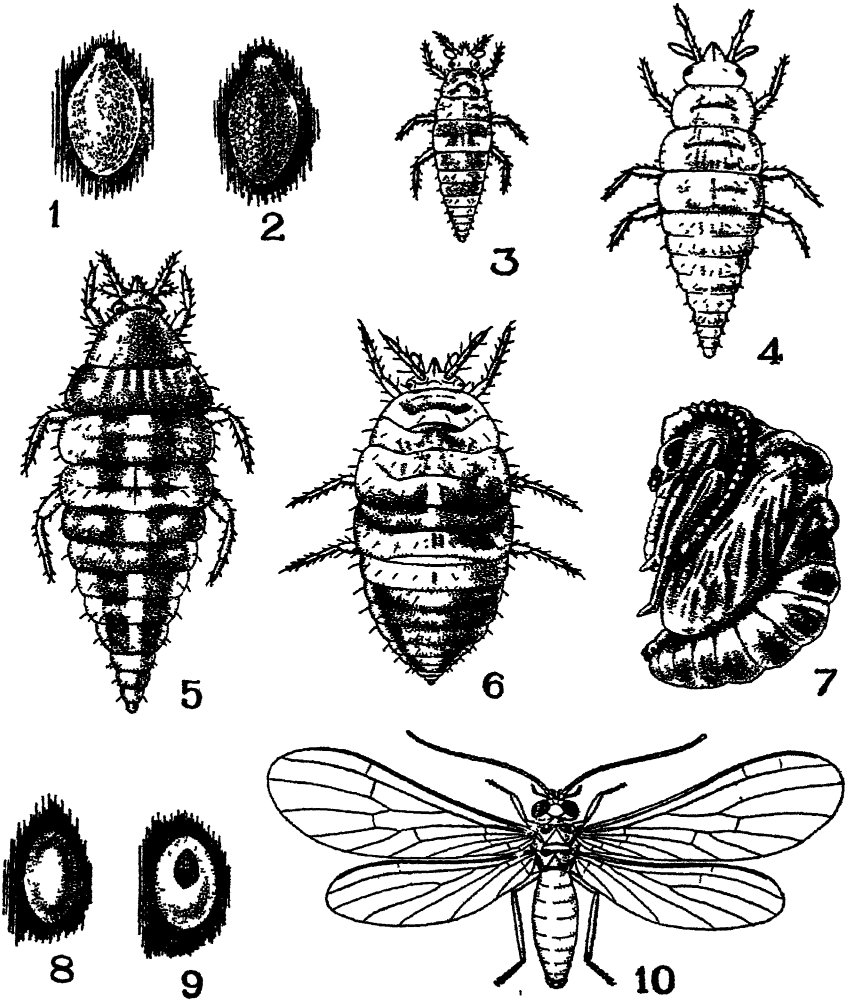
Oviposition and Description of the Eggs.—The female lays eggs singly, generally on the under surface of leaves in close proximity to the *Pyrilla* egg masses. When freshly laid, the egg is slightly creamy in colour becoming pinkish at about the time of hatching. It is 0·5 mm. long and 0·27 mm. broad in the middle (Figs. 1 & 2). It is oval in shape with the micropylar end drawn out into a blunt conical projection. The chorion is characteristically honey-combed with distinct polygonal depressions, which are very clearly seen under the high power of the microscope. The chorion slits longitudinally at the time of hatching. During the summer months, July, August and September, the egg hatches in about four to five days when the mean maximum temperature is about 81·5°F., the mean minimum 79·5°F., and the average relative humidity 86 6%. With the beginning of cold weather, November, December, January and February, it usually takes from eight to twelve, sometimes even fourteen days for the eggs to hatch when the mean maximum temperature is 76°F, the mean minimum 50·5°F. and the average relative humidity 82·6%.

Description of the larval stages and the duration of summer and winter life cycles.—The larva (Fig. 3) just after hatching halts near the empty shell for some minutes and then actively moves about in search of food. It is very light pinkish in colour and is 0·75 mm. long and 0·20 mm. broad in the middle. The first instar larva does not differ much from the later ones except that the empodium between the two tarsal claws is pointed in the first instar larva whereas in the second and third instars it is pad-like. The larva is pyriform and is flattened dorsoventrally. The body is smooth but the thoracic segments bear double transverse rows of fine hairs while the abdominal segments bear only single rows. The labrum covers the conical mouth parts that are adapted for sucking purposes. The mandibles and the maxillæ constitute the sucking spears. The mandibles are pointed and have shallow grooves ventrally. The maxillæ are also modified for sucking. They are pointed and have barbs near their tips. The labium is very much reduced and lies between the two jaws. The labial palpi are three-jointed, the distal joint being club-shaped. The thorax is about or little more than half the length of the whole body. The prothorax has a pair of spiracles. The legs are long and covered with long hairs. The tarsus consists of one segment only and is not freely articulated with the tibia. The abdomen consists of ten segments, is broad in the anterior region, gradually tapering towards the posterior extremity. The first eight segments have each a pair of spiracles. The second instar larva (Fig. 4) is 1·25 mm. long and 0·4 mm. broad, and the third instar (full-grown) larva (Fig. 5) is 2·25 mm. long and 0·75 mm. broad. When full fed, the larva moves the anal spinneret over its back backwards and forwards and spins over it a cover of silk, inside which another smaller cover is spun. Pupation takes place inside these covers. The larval period during the summer months is about 18 days and pupal period about 10 days. In winter the larval period is about 25 days and the pupal period about a month. The pupa (Fig. 7) has its appendages free. It does not make any movements until about two months. With the aid of mandibles the adult makes a rough circular slit in the anterior region of the cocoon and emerges.

ACKNOWLEDGMENT

The biology of the predator was studied in the Entomological laboratories of the Imperial Agricultural Research Institute, Pusa

and New Delhi and I wish to express my sincere thanks to Dr. Hem Singh Pruthi, Imperial Entomologist, for granting me all the necessary facilities and for helpful guidance throughout the course of the work.



Figs 1-10 —*Coniopteryx pusana* Withycombe.

1 and 2 The egg; 3. Freshly-hatched larva; 4. 2nd instar larva, 5. 3rd instar larva; 6. Full-grown larva about to pupate (Note the shrunken size), 7. Pupa; 8. Cocoon; 9. Cocoon showing the slit, 10. Adult.

SUMMARY

The bionomics and life-history of *Coniopteryx pusana* Withycombe, a predator on the eggs of *Pyrilla* has been studied. During the summer months of July, August and September it takes four weeks for the completion of the life-cycle, when the mean maximum temperature is about 81·5°F; the mean minimum 79·5°F and the average relative humidity 86·6%, while during the winter months of November, December, January and February, the life-cycle is completed in just over eight weeks when the mean maximum temperature is 76°F., the mean minimum 50·5°F., and the average relative humidity 82·6 %.

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THE BIOLOGY OF *MICROBRACON CHILONIS* VIERECK—A LARVAL PARASTTE OF *CHILO ZONELLUS* SWIN.

By M. C. CHERIAN, B.A., B.SC., D.I.C., and P. S. NARAYANASWAMI, B.SC., AG.
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INTRODUCTION

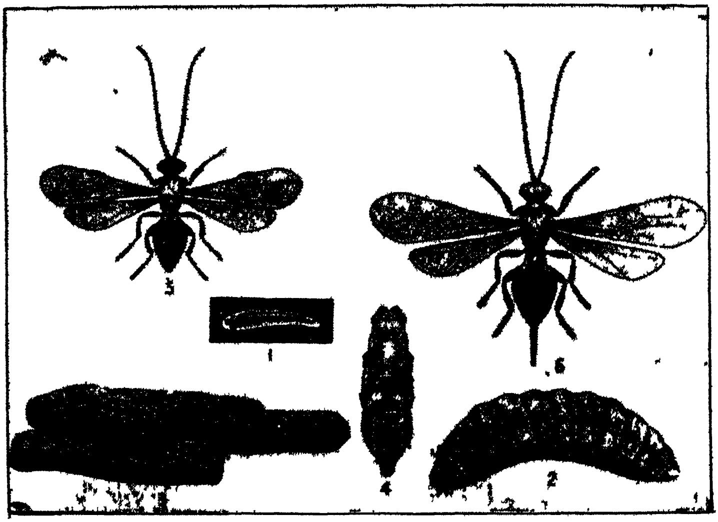
Microbracon chilonis Vier. is one of the few braconid parasites that are known to attack the sorghum borer *Chilo zonellus* Swin. It was described by Viereck (1913); and is identical with *Microbracon chilocida* described by Ramakrishna Ayyar (1928).

HABITS AND LIFE-HISTORY

Mating.—Soon after emergence the adults of both sexes are ready for mating. Only at close quarters the male seems to be aware of the presence of the female and it shows its eagerness by running towards the female, with the antennae oscillating. If the female does not object to the overtures of the male, the pairing is quickly effected and is continued till the female moves away. The whole process takes nearly 20 to 30 seconds for completion.

Oviposition.—When supplied with host caterpillars inside cholam (*Andropogon sorghum*) or maize (*Zea mays*) stems, the females freely parasitise them after paralysing them. Preoviposition period varies from 2 to 11 days. Host larvae when given naked, *i.e.*, when not supplied in a stem are not parasitised. When about to oviposit, the female walks about the stem containing the host, feeling the stem with its antennae, selects a suitable spot, thrusts its ovipositor into the stem and after paralysing the host, lays eggs. The adult does not feed on the host larva through the puncture made by the ovipositor as several other braconids do. Oviposition takes nearly 30 to 45 minutes and even an hour depending on the number of eggs deposited. The eggs are laid loosely in a cluster on any part of the host body and can be easily dislodged. The number of eggs laid by a female varies from one to a dozen on a host, the average for 74 hosts being 4.5 eggs. The maximum number of eggs laid by a female bred in the laboratory was 61 as against 84 laid by a parasite collected from the field. The average for 15 females worked out to 22.7 eggs.

Egg.—(Fig. 1) The freshly laid egg is smooth, shining, milky white in color and oblong-ovate in shape. It is slightly arched in the middle with the ends rounded but unequal. The posterior end has a small hollow space inside. It measures 0.882 mm. to 1.134 mm. in length and 0.200 mm. to 0.231 mm. width at the widest part, averaging 0.997 mm. in length and 0.222 mm. in width. The incubation period of the egg lasts from 24 to 30 hours with 27 hours as the average time. Before hatcking, it loses its transluscence and the empty space at the caudal end becomes filled up. The hatching larva gnaws out a circular opening at the broad end and crawls out of the egg shell. In most cases it comes clean out of the egg shell while in some the egg shell remains attached to the larva till the first moult. The newly hatched larva crawls on the surface of the host body, fastens itself to the host with its mandibles and begins to feed by inserting its mandibles into the body tissues and imbibing the body fluid



FIGS. 1-6.—*Microbracon chilonis* Viereck.

1. The egg; 2. Larva; 3. Cocoon; 4 Pupa, 5. Male; 6. Female

Expl.

Larva—(Fig. 2) The newly hatched larva is about the same in size, shape and color as the egg excepting that it is a bit more flat and not so tapering towards the posterior end. It is composed of a head and 13 distinct body segments. The cuticle of the larva bears very minute setae not visible to the naked eye. The head bears on its dorsal surface a pair of minute non-segmented antennae and on its lower side the mouth parts. The larva measures 0.903 mm. to 1.120 mm in length and 0.195 mm to 0.215 mm in width, averaging 1.017 mm. in length and 0.213 mm in width. The full-grown larva is cylindrical, well arched and tapers off at the extremities rather more towards the head than towards the posterior end. The mouth parts are fairly well chitinised from the lower part of the head. The white urate granules inside the body are large and conspicuous. The growth of the larva in the final stages is very rapid. The full-grown larva measures 5.086 mm. to 6.536 mm. in length and 1.300 mm. to 1.806 mm. in width with 5.874 mm. and 1.481 mm. as the average length and width. It attains full growth in the course of 3 days from the time of hatching when it stops feeding. Each larva when full fed spins its own cocoon within which it pupates.

Cocoon.—(Fig. 3) The cocoon is spun within the course of a day or even less. It is pale to dirty white in color and somewhat larger than the larva. It consits of tough silken threads and is firm in texture. It is elongate cylindrical in shape with the anterior end terminating in a spherical cap. Several cocoons may be found grouped together. The cocoon of the female is always larger in size than that of the male by about a fifth, the female cocoon measuring 6.172 mm. to 7.516 mm. in length and 2.193 mm. to 2.623 mm. in width with 6.667 mm. and 2.300 mm. as the averaging length and width while the male cocoon is 4.946 mm. to 6.116 mm. in length and 1.634 mm. to 1.980 mm. in width with 5.412 mm. and 1.845 mm. as the average length and width. After completing the cocoon the larva remains queiscent for nearly 4 to 5 days when it evacuates the accumulated larval meconium in small yellowish lumps, moults for the last time and turns into the pupa.

Pupa.—(Fig. 4) The pupa is smaller than the larva. When fresh, it is creamy-white in appearance but it gradually begins to darken in color. The eyes turn pink, then dark and the other organs also in turn slowly assume the hue they bear as adults. It takes 5 to 6 days to have all the organs well formed and chitinised. The adult splits open the pupal skin and gets ready to emerge out of the cocoon. The female pupa measures 4·300 mm. to 6·129 mm. in length and 1·330 mm. to 1·978 mm. in width, averaging 5·356 mm. and 1·688 mm. in length and width. The male pupa is smaller than the female being about four fifths its size. It measures 3·570 mm. to 5·332 mm. in length and 0·960 mm. to 1·548 mm. in width with 4·584 mm. and 1·305 mm. as the average length and width.

Emergence of the adult from the cocoon.—The adult parasite after freeing itself from the pupal skin waits for sometimes inside the cocoon for the body to get hardened. It cuts out a circular opening through which it comes out head foremost with the help of its legs and emerges out finally.

Life-cycle.—The whole life cycle of the parasite from the egg to the emergence of the adult lasts from 12 to 15 days, the egg, larval, prepupal and pupal periods being 1, 3, 3-4 and 5 to 7 days respectively. The life cycle averaged 13 days for 25 specimens. The maximum and minimum temperatures and the relative humidity for the period are as follows :—*June*—88·9°, 73·4° and 72% ; *July*—85·3°, 72·5° and 73·3% ; *August*—80·6°, 71·8° and 70·0%.

Longevity.—The imaginal life is fairly long ; when fed with sugar solution, the female lives for 4 to 55 days with 16·5 days as the average duration of life for 23 females while the male lives from 3 to 59 days with 14 as the average for 31 males.

Parthenogenesis.—Parthenogenesis is found to occur, the progeny being all males in such cases. It has been noticed that parthenogenetic females oviposited earlier than mated females but the number of eggs deposited by the former was always less.

Alternate hosts.—In the field, the parasite has also been found parasitising the caterpillars of *Argyria sticticraspis*, H. The parasite was successfully reared in the laboratory on the larvae of *Diatraea venosata*, *Argyria sticticraspis*, *Corcyra cephalonica* and *Galleria mellonella* but it was found to be less inclined to parasitise the latter two.

ACKNOWLEDGMENTS

Our thanks are due to Mr. C. F. W. Muesebeck of the United States Bureau of Entomology, Washington, for the identification of the parasite.

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A NEW SPECIES OF CHRYSOMELIDÆ FROM BURMA

By G. D. Bhasin, b.sc., *Forest Research Institute, Dehra Dun, U. P.*

Subfamily Hispinae

Platypria garthwaitei, new species

Reddish-brown; the prothorax with the lateral lobes pale fulvous, two slightly oblique vittae on the disc (one on each side of the middle line), extending from the basal depression to a little beyond the middle, black; the elytra with the tubercles on the disc black, the marginal spines except two in the concave interval and a few on the apical margin towards the suture, black or tipped with black; the areas round the larger basal semihyaline depressions in the anterior and posterior lobes suffused with black and the margin of the concave interval yellow.

Head with a projection in the interantennal space and a longitudinal impressed line down the middle. The antennæ long and slender, the first joint stout, the second small, the third the longest and slender, the following joints except the last becoming successively smaller. Prothorax broader than long, transversely depressed in front of the base, the surface rough except a few punctures in and near the middle of the basal depression, the lateral expansions directed forward, each having six spines, the most anterior of which is very small and bears a small seta at its tip, second the longest, third, fourth and fifth rather broad and blunt, sixth a little longer, in addition to these spines the hind portion has a few small teeth or sometimes a short spine; the disc of each expansion with three elongate depressions with semihyaline centres. Scutellum triangular with the apex rounded, the surface rough with a shallow depression. Elytra shining, punctate striate; the costæ bear several minute black tubercles the number of which varies in individual specimens and two large conical tubercles on each elytron one before and the other behind the middle, the one before the middle is more slender and acute than the one behind. The anterior lateral lobe is armed with six spines and bears a large more or less circular hyaline depression basally and four other small elongate depressions (one each at the base of spines 2 to 5), also there are one or two very small depressions anterior to, and one posterior to, the large depression; the concave interval between the anterior and posterior lobes with two minute yellow spines; posterior lobe with three slender spines and four depressions, the basal two being the larger; the spines on the apical margin gradually decrease in length towards the suture, the three immediately following the posterior lobe are coloured as the spines of the lobes, the rest yellow; each of the marginal spines except the two in the concave interval bears a very small seta near the tip. Length, 6 mm.

Described from a series collected defoliating *Zizyphus incurva,* Maymyo, Burma (P. F. Garthwaite VII. 1938 and M. H. Desai V. 1940) Type and paratypes in the Forest Research Institute, Dehra Dun, U.P.

In Maulik's key * to the Indian species of the genus this species fits in with *P. chiroptera* Gestro with which it agrees in having the antennae long and slender, the elytron not hairy and the anterior lateral lobes with six spines but differs as follows:—the prothorax devoid of hairs, the longitudinal stripes oblique; elytra with a very conspicuous basal semihyaline depression in the anterior lateral lobe and two spines in the concave interval.

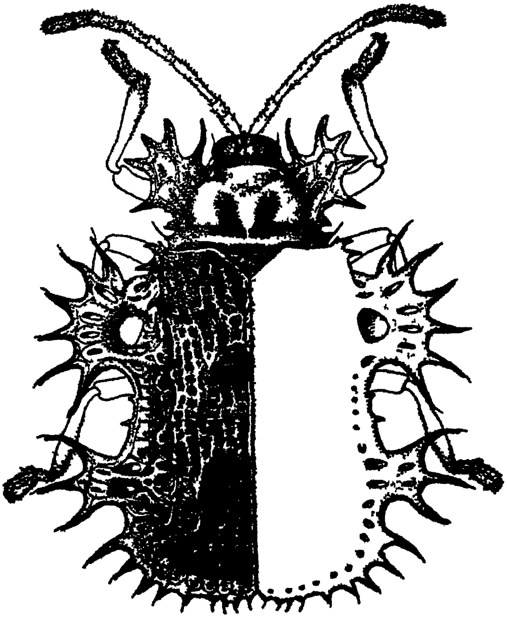

Fig. 1—*Platypria garthwaitei*, sp nov ;
Dorsal view of the beetle

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* 1919, Fauna Brit. India. (Hispinæ, Cassidinæ) p. 257.

RE-ASSOCIATION OF MALPIGHIAN TUBULES IN COCCINELLID BEETLES.

(*A Hydro-Filter Device for Water-Conservation*)

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Introduction

The problem which forms the thesis of the present paper has been a mystery to science for over a century and a quarter, and it has been occupying my mind for a number of years during which I have been busy on the study of the lady-bird-beetles (Coccinellidae). The malpighian tubules in a typical case, are blind excretory tubules arising at the junction of mid—and the hind-gut and hanging freely in the body cavity, but in a number of insects including the lady-bird-beetles, the distal ends of these tubules instead of remaining free in the body cavity, show a close adherence to the walls of the colon and rectum (Figs. 1 & 2).

This re-association of malpighian tubules with the hind-gut, even according to such early studies as those of Ramdohr, (1811), quoted by Woods, (1916), occurs in at least 22 genera of Coleoptera representing 10 families, 2 genera of Neuroptera, 3 genera of Hemiptera, 1 genus of Lepidoptera, 3 genera of Hemiptera, 1 genus of Lepidoptera, and 1 genus of Diptera. Later studies have certainly added largely to this list; Woods' valuable historical account (1916) of the work done on this subject renders it unnecessary to review the previous literature. More recently Ishimori (1924) has again summarised the work and has studied the similar arrangements in a large number of Lepidopterous larvæ and has classified the various types of convolutions shown by the re-associated portions of the malpighian tubules. Thus it will be clear that the re-association of malpighian tubules is a phenomenon of fairly common occurance among the insects.

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*The work was done in the Zoological Laboratories of the University of Lucknow and the paper was finally prepared for publication in the laboratory of the Imperial Entomologist, New Delhi.

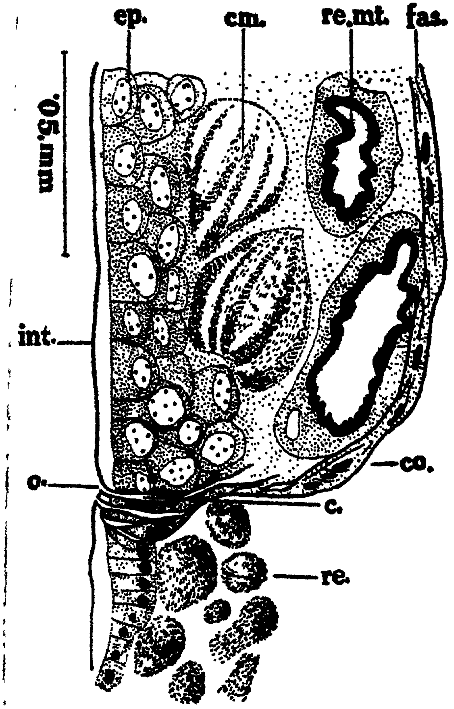

FIG. 2.

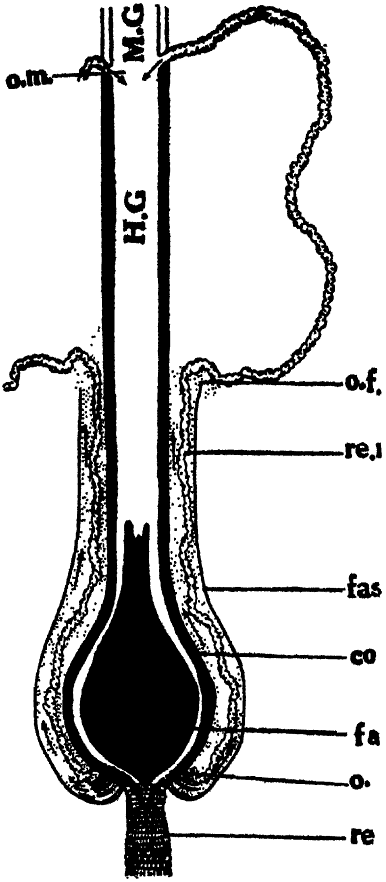

FIG. 1.

Fig. 1. Diagrammatic sketch showing re-association of malpighian tubules in Coccinellids.

Fig. 2. Longitudinal section through the junction of colon and rectum of *C. septempunctata.*

c.—canaliculi leading from the lumen of the gut to the fascial envelope; *cm.*—circular muscles; *co.*—colon; *ep.*—epithelium; *fas.*—fascial envelope; *fae.*—fæcal matter; *H.G.*—hind-gut; *int.*—intima; *M.G.*—mid-gut; *o*—opening in the intima at the junction of colon and rectum; *o.f.*—opening of the fascial envelope (chamber); *o.m.*—opening of the malpighian tubules at their origin from the junction of mid—and hind gut; *re.*—rectum; *re. mt.*—re-associated portions of malpighian tubules.

The significance of this re-associat on of the malpighian tubules has defied all investigative efforts. The present paper, without claiming a complete solution of the problem is meant to throw some additional light on this subject which has gleamed forth during my studies on Coccinellid bettles. The results incorporated herein go a long way to prove that this re-association is a unique *Hydro-filter device* for water conservation.

II.—STRUCTURE OF MALPIGHIAN TUBULES IN COCCINELLID BEETLES

The account recorded herein is based on a close study of *Epilachna indica* Muls. and *Coccinella septempunctata* Linn. and a general study of five other Coccinellid species namely *Chilomenes sexmaculata* Fabr., *Brumus saturalis* Fabr., *Synia millanaria* Muls., *Chilocorus nigritus* Fabr., and *Epilachna vigintioctopunctata* Muls. The description of the histological structure of malpighian tubules given in the case of *E. indica* (Pradhan, 1937) applies fairly closely to these species also. During the present investigation, therefore, attention has been paid to observations additional to those already made in *E. indica.*

The malpighian tubules are six in number. They originate independently from the annulus round the plyoric valve and travel forwards in a zig-zag course along the length of the mid-gut and then turn back and travel backwards in a similar manner up to the hinder portion of the ileum, where they begin to surround the gut intimately in a very convoluted fashion, and completely invest both the hinder portion of the ileum as well as the colon (*Co.*, figs. 1 & 2). These re-associated portions of the malpighian tubules are enclosed within a fascial envelope, which follows the contour of the colon. Posteriorly this fascial envelope is intimately connected with the junction of the colon and rectum. Here it pierces the musculature as well as the epithelium and becomes attached to the intima (*int*). Anteriorly, however, the envelope continues up to the level where the malpighian tubules begin to re-associate, and there ends *without any intimate connection with the gut wall.* Thus the fascial envelope is an open-necked flask-shaped structure enclosing the colon and the re-associated portions of the malpighian tubules—the bottom of the flask being fused with the junction of colon and rectum and the neck rather loosely surrounding a short portion of the ileum but leaving free luminal connection (*o. f.*) between the inside of the fascial envelope and the rest of the body cavity. This luminal connection has to be carefully noted as the previous workers have definitely overlooked this point and as this point is of special importance in deciding the significance of re-association.

Microtome sections through this re-association complex reveals another still more unique anatomical peculiarity. Sections through the junction of colon and rectum show under high powers of magnifications very minute openings in the intima (*O*). These openings, however, are not found all round the junction but only along the radii of the longitudinal folds. From the lumen of the colon, the openings lead through very minute canaliculi (*C.*) traceable in the tissue of the longitudinal folds to the chamber formed by the fascial envelope. The significance of these openings seems to lie in the fact that they establish a luminal connection between the lumen of the hind-gut and the body cavity through the fascial envelope. The cells at the junction of the fascial envelope with the intima and also for a short distance along the canaliculi are characteristically spindle-shaped and minute.

Apparently somewhat similar structure has been described by Landis (1936) who has reported these openings in the intima of *Ceratomegilla fuscilabris* Muls, which, however, unlike the species examined by me appears to have these openings all round the junction of colon and rectum. But, Landis has reported still another observation which I cannot corroborate and which renders my observations as a whole diametrically opposed to that of Landis. He writes that at "the points of attachments" between the malpighian tubules and the fascial envelope "ducts open into the wall of the tubule through which a part of the contents of the collapsed cells of the tubule streams out into the matrix of the peritoneal tissues". This observation of Landis establishes a luminal connection howsoever indirect between the lumin of the gut and that of the malpighian tubules instead of the luminal connection between the gut and the body cavity shown by my observations. I, however, have not been able to observe any luminal connection between the malpighian tubules and the chamber in which they lie.

III.—FUNCTIONAL STUDY OF THE RE-ASSOCIATED PORTION

Besides structural studies, I have carried out the following experiments with a view to investigate the function of the re-associated portions of the malpighian tubules. These observations have been repeatedly made on *C. septempunctata* and *E. indica.*

Exp. 1. After cutting off the wings of a living beetle, I quickly cut off its sides together with its legs with a pair of fine scissors and dissected out the intestine in salt solution (0·9% Na Cl and 0·1% K Cl)* as quickly as possible. I than transferred the intestine to a cavity slide and added a few drops of Neutral Red dissolved in the same salt solution. After two minutes I washed off the Neutral Red and examined the intestine in salt solution under the low power of the microscope. It was observed that:

1. The free portions of the malpighian tubules became intensely red stained whereas the re-associated portions did not take up the stain at all, proving that the two portions have different functions.
2. In about fifteen minutes the malpighian tubule transferred the stain to the gut at the point of their origin, and no stain travelled within the malpighian tubules towards the re-associated portions, proving that the malpighian tubules discharge their contents into the gut only at one point namely at their origin (*O.M.*) and not in the region of the re-association also as has been interpretted by Landis (1936).

Exp. 2. The intestine of another specimen was dissected out as in experiment 1, and the re-associated portions of the malpighian tubules were carefully peeled off and treated as in exp. 1, and it was observed that on being thus separated the re-associated portions of the malpighian tubules also like their free portions took up the neutral red, which they did not do when they were covered over (as in exp. 1) by the fascial envelope. Thus it was revealed that the re-associated portions were not incapable of taking up the excretary material as may be concluded from the exp. No. 1.

Exp. 3. Exp. 1 was repeated and the intestine was kept in a weak solution of Neutral Red for about an hour, when the following observations were made:—

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* Similar observation was first made by Metalnikov (1908) by injecting vital dyes in the body cavity.

1. After some minutes strong peristalisis began, the wave of contraction starting in the posterior portion of the ileum at the point of re-association and continuing right up to the end of the colon, but these repeated waves of peristalsis did not result in the defaecation of the colon contents (*fae*) as was expected from the nature of peristalsis. Evidently the defaecation was being prevented by the rectal sphincter being kept tightly closed. These strong waves of peristalsis without resulting into defaecation did not admit of any other inference except that during that action the liquid portion of the colon contents was being pressed out through the intimal pores into the fascial envelope. Further it was clearly observed that the liquid from within the fascial envelope flowed into the body cavity through the anterior opening of the envelope where the re-association begins. This observation was possible because the liquid within the fascial envelope was kept well stirred due to the peristalsis of the colon and the movement of the liquid was clearly visible under the low power of the microscope with the aid of a strong electric light focussed by the reflector of the microscope. Sometimes however a small amount of liquid was sucked into the envelope through the same anterior opening and the neutral red particles thus carried within were taken up by the re-associated portions of the malpighian tubules as was proved when at the end of this experiment the re-associated portions were peeled off and examined under the high power of the microscope.

IV.—SIGNIFICANCE OF RE-ASSOCIATION

(a) *Previous Views*

As already stated, Wigglesworth, (1934) remarked that "the precise significance of this arrangement is not known" although the problem has been subject of much speculation and conjecture ever since it was shown that the posterior termination of the malpighian tubules in the wall of the hind-gut is rather apparent and superficial. Metalnikov (1908), however, seems to be the first to make any experimental study of this subject by injecting various vital dyes into the body cavity of *Galleria* sp. To quote Woods (1916), Metalnikov "formulated the hypothesis that this part of the tube constitutes a special secretory apparatus which eliminates such toxic substances as may have passed through the intestinal epithelium. This is the opinion of Payorkoff (1910) and substantially that of Gorka (1914)". Woods (1916) himself suggested that in *Haltica bimarginata*, probably the liquid absorbed by the mid-gut epithelium travels backwards between the basement membrane and the circular muscles till it reaches the region of re-association where it passes out and is cleaned by the re-associated portions of the malpighian tubules before entering the general haemocoele. In 1933, R. Heymons and M. Luhmann repeated the experiments of Metalnikov by injecting Indigo-carmine into the body cavity, and arrived at similar results. They wrote: "Wir sind zu der Uberzeugung gekommen, dass es sich hier um einen Apparat handelt, der fur den Wasserhaushalt im Organismus des Kafers und seiner Larve wichtig ist. (In diesem Zusammenhang sei erwahnt, dass der Schneebalkafer feuchte Standorte liebt und, am besten in feuchter Umgebung gedeiht. Er kann als hygrophil bezeichnet werden) Seine Funktion durfte etwa die folgende sein. Man darf annehmen, dass im Enddarm wie bei anderen Insekten eine gewisse Eindickung des Darminhalts stattfindet, und zwar durch Entziehung von Flussigkeit, die mit Hilfe des resorbierenden Darmepithels dem Blute zugeleitet wird. Bei Galerucella und, wie wir vermuten mochten, auch bei verschiedenen anderen Chrysomeliden gelangt aber die von der Darmwand aufgesogene Flussigkeit nicht direkt in die gemeinsame Korper hohle, sondern zunachst in den Kammerraum, in dem sie mit Hilfe der Endabschnitte der Vasa Malpighi wahrscheinlich von schadlichen Beimischungen befreit, in gewissem Sinne also gereinigt wird. Der eigenartige Kammerartige Raum ist hiernach als eine Art Filter-kammer zu betrachten. Die oben beschriebene Unterbrechung, die das Enddarmepithel in Form einer ringformigen Dusenzone zeigt, mochten wir dabei als eine Art Ventil deuten. An dieser zone besteht die Darmwand nur aus einer dunnen Chitinscicht, die bis zu einem gewissen Grade als durchlassig gelten kann. Diese Stelle durfte vielleicht zum Ausgleich von Druckschwankungen dienen und auch einen Durchtritt von Flussigkeit wieder aus dem Kammerraum zuruck in den Enddarm moglich machen".

In 1934, Wigglesworth made a passing remark that "perhaps this serves to add the absorptive powers of the malpighian tubules to those of rectal epithelium". The latest contribution on this subject, however, has been made by Landis (1936), who after working on *Ceratomegilla* sp. (Coccinellidæ) was led to the belief that there is an indirect passage through which the liquid wastes are passed into hind-gut in the region of re-association besides the normal discharge of the excretory product at the origin of the malpighian tubules.

It will be clear that there are two main views on this subject besides the suggestions of Wigglesworth.

The one view is that the re-associated portions ending absolutely blindly are meant to extract toxic material that might pass through the intestinal wall. Evidently the believers in this view suspected the efficiency of the epithelial cells in their vital function of selective absorption which must be sub-normal to require a special apparatus like the re-association complex to supplement their function.

The other view namely that of Landis is that the re-association provides an additional indirect connection between the malpighian tubules and the hind-gut, meaning naturally thereby that the malpighian tubules discharge their excretion into the gut at two points, firstly at the point of origin at the junction of mid—and hind-gut and secondly in the region of their re-association on the wall of colon or rectum.

(*b*) PRESENT VIEW

That the free and re-associated portions of the malpighian tubules are meant for different purposes is an almost established fact as repeatedly proved by experiments of previous workers as well as those described in the present paper. As to the actual function of the re-associated portion, experiment No. 3 described before has given an indication that the liquid portion of the colon contents is pressed out into the fascial chamber, and further in the same experiment it has been clearly observed that the fluid content of fascial chamber flows out into the haemocoele. It should be, therefore, quite reasonable to conclude that the re-associated portion of the malpighian tubules enclosed within the fascial chamber are meant to clean the liquid pressed out from the colon contents before it flows into the general haemocoele, the special necessity ton such cleaning being due to the fact that the liquid from the colon comes into the fascial chamber not after being normally absorbed by the epithelial cells which themselves exercise selective absorption but after being only mechanically pressed out through the pores of the intima as if through a sieve.

Now let us test this interpretation against the two main views existing on the subject.

As to the view of Landis regarding the discharge of liquid excretion of malpighian tubules in the region of re-association, it seems very unlikely that the excretory material within the lumen of the malpighian tubules should choose such an indirect and complicated course as the minute canaliculi and the intimal pores provide, specially when the normal course is so easy and without obstacles (of course longer). Besides, the experiment No. 1 establishes beyond doubt the direction of the flow of the liquid to be towards the origin of the malpighian tubules and not towards their re-association. It may be added that the passage of the liquid from the gut into the fascial envelope takes place under the pressure of peristalsis of the colon.

Even if we accept Landis' interpretation that "a part of the contents of the collapsed cells of the tubules streams out into the matrix of the peritonial tissue—a point which I might not have been able to appreciate—it is absolutely impossible to accept his suggestion that after entering the peritonial matrix, the liquid wastes appear to be transported posteriorly to the insertion of the peritonium on the intima of the intestine" specially when the experiment No. 3 reveals beyond doubt that the liquid from inside the fascial envelope flows out into the general body cavity; and when this latter suggestion of Landis is not feasible his former one regarding the discharge of the excretory material within the fascial envelope becomes altogether unlikely because that will mean sending the excretory material to the body cavity and thus to counteract without any purpose, the function of the malpighian tubules which they exercise in most insects.

As regards the views of other workers besides Landis who believe that the re-associated portions of the malpighian tubules are meant to extract any toxic matter that might pass through the gut epithalium the following is worth nothing. Evidently the believers in this view suspected the efficiency of the gut epithelium in their normal vital function of selective absorbtion which must be sub-normal if a special apparatus like the re-association complex is required to supplement it. It is quite pertinent to ask as to how a great majority of insects which are without re-association complex, get rid of such toxic substances. Moreover, the suggested passage through which the liquid absorbed throughout the gut length should pass to come to the fascial chamber is also problematic.

Coming to the new interpretation presented in this paper, the necessity for the economy of water is an unquestionable issue and it is likely to be a special necessity for coccinellids as they remain throwing out intermitently a good deal of water in the form of reflex bleeding as will be explained later. It is therefore not unlikely that the re-association complex is forming a special device for water conservation. To quote Wigglesworth (1934), the re-association of malpighian tubules with the colon and rectum is co-related with a strong power of drying the excrement. A reference to Wigglesworth's work on the significance of rectal glands in insects (1932) and Prof. Bahl's work on the significance of enteronephric system in earthworms (1934) will oppose the view of Landis that the liquid is poured out into the colon and will strongly support the present interpretation that the liquid portion of the colon contents is pressed out into the fascial envelope and is retained back for the use of the body again. By the way, it may also be noted the position of pores (*o*) in the intima and the characteristic shape of the colon (*Co.*) are both ideal for this pressing action.

It might be contended that the liquid pressed out from the colon contents into the fascial envelope must be too dirty to be sent to the general body fluid, but this contention is not only itself explained by, but actually explains the enclosure of the so-called re-associated portions within the fascial envelope; the experiment No. 2 has proved that the re-associated protions are not incapable of taking up the excretory material.

Before concluding it may be interesting and instructive to recall in this connection that the malpighian tubules are characteristically confined to the mainly terrestrial Arthropods (*i.e.* most Insects, Myriopods, and Arachnids). In those groups of Arthropods, on the other hand, which have been primarily aquatic *i.e.* Crustacea and Xiphusora (Limulus) the renal excretion is supposed to be performed by nephridial glands*. Now the main physiological difference between these two types of renal structures is that whereas the latter throw the liquid excretion outside the body, the former discharge it into the gut whence the water component of the excretion can be absorbed back and retained into the body. Thus it is not very improbable that even the original development of the malpighian tubules might have been connected with the need for water conservation during the change from aquatic to terrestrial life This idea will be better appreciated after a reference to Prof. Bahl's work on the significance of Enternephric system in Oligochaetes (Annelids—verily the ancestors of Arthropods) wherein he concludes that the discharge of the excretion into the gut is a means for retaining back the water-content of the excretion.

(*c*) RE-ASSOCIATION AND REFLEX-BLEEDING.

There appears to be a special reason why the Coccinelled beetles should develop a special device for preventing the loss of water. The insects like many others are very prompt in what is known-as "reflex-bleeding". As soon as they are touched they almost instantaneously emit out a lot of an offensive liquid which is supposed to defend them against their enemies. Whatever may be the nature or source of the liquid. the major portion of it may safely be presumed to be water. If 'this presumption is correct then it becomes a decided fact that these insects have to throw away a large amount of water in self-defence. Therefore, it appears that it is to make good this special consumption of water that this is a special device for the conservation of water in the form of re-association complex. To establish finally the co-relation between Re-association and Reflex-bleeding, a survey of the whole class of Insecta may be needed but the following insects which have been studied from both these view-points (although separately) afford strong support to this suggestion by showing striking co-occurrence or re-association of malpighian tubules and the phenomenon of reflex bleeding.

(*A*) Coccinellids :—These insects have been studied for Re-association' by Ramdohr (1811), Potts (1927), Burgess (1932), Landis (1936), Pradhan (1937), etc., and for Reflex-bleeding by Lacordaire (1938), Leydig (1859), Luts (1825), Porta (1903), McIndoo (1916) etc.

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*Peripatus may be taken as an exception although it can be also grouped from the physiological point of view with the aquatic arthropods as it inhabits damp localities. Of course it may not be necessarily always this very co-relation; it is just possible that in some other insects with re-association the extra-consumption of water may be taking place in some other way.

(*B*) Chrysomelids:—They have been studied for Re-association by Ramdohr (1811), Dufour (1843), Payorkoff (1910), Woods (1916), Heymons and Luhmann (1933), etc. and for Reflex-bleeding by Lacordaire (1838), Leydig (1859), Cuenot (1890), De Bono (1889), Porta (1903) etc.

(*C*) Caterpillars:—Of the various workers Ishimori (1924) has studied the re-association in the largest number of caterpillars. Quite expectedly from the present point of view the literature contains an equally large number of instances of caterpillars emiting an 'urticating secretion' on being handled. Packard (1909) has given a good resume on "defensive or repugnatorial" secretions of caterpillars.

(*D*) Meloidæ (Cantharidæ):—(Blister beetles)

The Reflex-Bleeding in blister beetles is a well-known phenomenon and has attracted the attention of almost all the workers in the field. On the other hand I did not find any reference to the condition of the malpighian tubules of these beetles at least in the literature available to me. By way of testing, the proposition co-relating Reflex-bleeding and Re-association, I dissected a few blister (species ?) and found a much more perfect re-association than what has been described in any of the above mentioned insects. In the species dissected the re-associated portions fuse at short but irregular intervals and form a close-meshed net-work.

V.—Summary and Conclusions

The paper embodies some anatomical and physiological studies on the re-associated portions of the malpighian tubules in Coccinellid beetles leading to the following conclusions:—

(1) There is a luminal connection between the haemocoele and the hind-gut in the region of re-association as detailed below.

(2) The water from the excreta (*fae.*) stored in the colon is mechanically pressed out through minute epenings at the junction of colon and rectum into a fascial envelope which encloses the re-associated portions of the malpighian tubules round the colon, this pressing out being effected by local anteroposterior peristalsis of the colon while the rectal sphincter is kept tightly closed.

(3) Within the fascial envelope the re-associated portions of the malpighian tubules extract the toxic substances from the pressed out water.

(4) From the fascial envelope the water, after purification as if in a sewage house, enters the body cavity through the anterior opening of the fascial envelope.

(5) Thus the re-association of the malpighian tubules is a necessary accompaniment of the existence of minute pores at the junction of colon and rectum and the two together constitute a unique *Hydro-Filter Device* to prevent the loss of water to the insect body—a device the existence of which might subsequently be proved in all the insects having re-associated malpighian tubules.

(6) The existence of Hydro-Filter Device for water conservation appears to be strongly co-related with the extra-consumption of water due to Reflex-bleeding in a large number of insects including Coccinellids.

The above conclusions differ.

(*a*) from those of Landis (1936), the latest worker on the subject, mainly in the fact that the present studies establish a luminal connection between the gut and the body cavity instead of a connection between the gut and the malpighian tubules as established by Landis in the region of re-association—this anatomical difference leading as a natural course to a diametrically opposite interpretation of the function of re-association.

(*b*) from those of workers before Landis mainly in the fact that the present studies identify the existence of a mechanical filter of sieve the passage of water through which is not controlled as usual by the selective absorption exercised by the gut epithelium, thus giving rise to the necessity of a sewage house in the form of the re-association complex in the way—an idea which did not exist before.

SYNOPTICAL REPRESENTATION OF HYDRO-FILTER DEVICE

Use:— Conservation of water.

Necessity:— To maintain the following balance :
Extra water—consumption in Reflex-bleeding.
Extra water—conservation by Re-association.

Process:—
A. Mechanical pressing out of water by peristalsis of the colon.
B. Mechanical separation of water by the minute pores in the gut wall
C. Cleaning of water by vital activities of the malpighian tubules.
D. Entry of water into the body cavity through the anterior opening of the fascial envelope.

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* This book has actually appeared after writing this paper but the works reviewed in this book have not necessitated any alteration in the original thesis.

"Indian J. Ent., 4 (1)"

STUDIES ON INDIAN *COPEOGNATHA* (*PSOCOPTERA*)

II. NANOPSOCETAE AND PSOCATROPETAE

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In an earlier part of this series* an account of the general morphology and classification of the Indian Copeognatha was given. According to the key included in that part, the Copeognatha are divided into eight groups...... Nanopsocetae, Psocatropetae, Atropetae, Amphientometae, Epipsocetae, Caeciliatae, Homilopsocida and Psocetae. It is now proposed to deal with the systematics of these groups starting with the Nanopsocetae and Psocatropetae in the present part.

Group NANOPSOCETAE

Small to very small psocids, clothed with short, fine hairs, some showing an alary dimorphism.

Head more or less oval in outline. Median epicranial suture present or totally wanting; frontal sutures invariably absent. Vertex of the epicranium smoothly rounded. Surface of the head with fine hairs. Eyes small, with comparatively few ommatidia; cornea with or without hairs. Ocelli present or wanting; when present, three, small, situated at the corners of a triangle, flush with the surface of the head. Antennae fifteen-jointed; the scape and the pedicel short and bulbous; flagellar segments long and cylindrical, with close-set microtrichia and a few bristly hairs. Maxillary 'picks' sub-cylindrical, with three apical tines. Maxillary palpi four-jointed (reported to be five-jointed in *Semnopsocus*!); segments with uniform-sized, short, fine hairs; last segment elongate-oval, with the apical half somewhat narrowed, or sub-globular (Eutroctidae); second segment without any sense-spur.

Pronotum dorsally visible; sometimes divided anteriorly into three lobes. Alinota well developed; in apterous forms generally forming an entire plate; in alate forms with the characteristic sutures of winged psocids. Sterna well developed; prosternum free; the meso-and meta-sterna fused together. Wings well developed or entirely suppressed; only the forewings present in Sphaeropsocidae; wings when developed usually folded one over the other and held parallel to the dorsal surface of the body while at rest, as in Termites and Embiids; venation very much reduced or normal;. areola postica when present narrow and subrectangular, lying more or less parallel to the hind margin of the wings; cu_2 and la having separate endings on the wing-margin; the latter fused with $m+cu_1$ at the base. Femora normal (Pachytroctidae) or very much broadened (Liposcellidae). Tibiae long and cylindrical, without spurs. Tarsi three-jointed. Ctenidia wanting. Claws with a preapical tooth.

Abdomen somewhat fusiform. Paraprocts and telson reduced; the former without any sense-field. Sub-genital plate of the female simple and hood-like, usually with a characteristic T-shaped chitinised area on the inner side. Female gonopods membranous and lamellate.

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* Indian Jour. Ent., **3** (1): 13-23.

This group includes the genera *Liposcellis* Motsch. (=*Troctes* Burm.), *Embidopsocus* Hagen, (=*Embidotroctes* Enderl., =*Stenotroctes* Enderl., =*Tropusia* Hagen (?)), *Sphaeropsocus* Hagen, *Pachytroctes* Enderl., *Psacadium* Enderl., *Tapinella* Enderl., *Psylloneura* Enderl., *Trigonoscelliscus* Enderl., *Paleotroctes* Enderl., *Peritroctes* Rib., *Eutroctes* Rib., *Belapha* Enderl., *Semnopsocus* Laing, *Cuixa* Navas (?), *Nanopsocus* Pearm. and *Nymphotroctes* Badn.

Pearman has recognised only two families under this group, *viz.*, (1) the Liposcellidae, to which he has assigned the genera *Liposcellis* and *Embidopsocus* as types and (2) the Pachytroctidae, to which the genera *Pachytroctes*, *Nanopsocus*, *Peritroctes* and *Tapinella*. The genus *Trigonoscelliscus* has been shown by Enderlein (1910, p. 76), the founder of that genus, to be closely related to (*Stenotroctes*) *Embidopsocus*. This evidently shows that, that genus also should be included under the Liposcellidae. The genera *Paleotroctes* and *Nymphotroctes* were placed by the protologists in the Pachytroctinae; further, Karny (1930) and Badonnel (1931) have provisionally placed the genus *Cuixa* Navas (1927) in the same family. Therefore, these three genera should go under the Pachytroctidae in the new arrangement.

The remaining genera, *viz.*, *Sphaeropsocus*, *Eutroctes*, *Semnopsocus*, and *Belapha* do not allow their inclusion under either of these families. Though I have no representative species of these genera in my collection, I have proposed the erection of two new families to include them for the sake of giving completeness to the scheme of classification adopted here.

The genus *Sphaeropsocus* was erected by Hagen (1882) for the fossil *S. konowii*, from the Baltic amber. He included this genus under the Atropinae in which he placed the now-distinguished Liposcellidae as well as the Atropidae. Later, Kolbe (1883) separated this genus and placed it in a special group, which he named Sphaeropsocini. Somehow, this grouping was not followed by any of the later systematists. Enderlein (1903, p. 208) pointed out that it should be placed in the Psoquillidae ; but, he himself later (1911, p. 291) placed it in the subfamily Pachytrocinae of the family Liposcellidae. So far only one species of *Sphaeropsocus* was known. In 1933, Hickman recorded a living species *Sphaeropsocus recens*, from Tasmania. From the data available now, based upon these two species, there can hardly be any doubt with regard to the affinities of this genus with the other Liposcellidae. It presents the same body-form, which is dorsiventrally compressed, the same type of antennae and eyes. But, the peculiar, hard and well chitinised forewings 'resembling the elytra of a beetle' with distinct veins, the total absence of hindwings, and the more or less shortened body appear to be characteristic-features of *Sphaeropsocus*. Liposcellidae have a relatively longer body and when wings are developed, both the pairs are present and distinctly membranous, with hardly any well demarcated veins. In view of these remarkable differences, I believe this genus should be placed in a separate family, the **Sphaeropsocidae.**

The genera *Eutroctis*, *Belapha*, and *Semnopsocus* can readily be distinguished from all the others of the group by the remarkably inflated and somewhat subglobular terminal segment of the maxillary palpi. It must be mentioned here that these genera were designated, by their protologists to different groups. *Eutroctes* was placed by Ribaga (1911) very near to

(*Stenotroctes*) *Embidopsocus* and laing (1925) placed *Semnopsocus* also very close to the latter; both these genera were thus indirectly placed under the family Liposcellidae. The genus *Belapha* was, however, placed by Enderlein, (1917), with much hesitation, in the family Caeciliidae, because it presented two-jointed tarsi. From what is known now, one can without any hesitation remove it from the Caeciliidae and assign it to the group Nanopsocetae, because it presents typical characters of that group, *viz.*, 15-(14?) jointed antennae, more or less collar-like prothorax and sub-cylindrical maxillary 'picks' apically produced into distinct tines. Further, the remarkable agreement of the structure of the terminal segment of the maxillary palpi of this genus with that of *Eutroctes* and *Semnopsocus*, which are undoubtedly members of the Nanopsocetae, leaves no doubt regarding its systematic position. It must also be pointed out in this connection that Enderlein himself had doubts with regard to the tarsal nature of *Belapha*; his figure, as well as description, show that the so-called second tarsal segment can easily be the fused second and third segments. I believe that these three genera should, therefore, be grouped together and placed in a separate family, the **Eutroctidae**.

The four families of Nanopsocetae recognised in this paper may be separated from one another by the following key:

1. Terminal segment of the maxillary palpi elongate-oval..................................2.

—. Terminal segment of the maxillary palpi sub-globular..EUTROCTIDAE.

2. Both pairs of wings either well developed or totally wanting..........................3.

—. Only the forewings developed, hard and elytra-like..........SPHAEROPSOCIDAE.

3. Pronotum anteriorly tri-lobed; wings when developed, the anterior pair with only two longitudinally-running, faintly demarcated veins and the hindwings without any; the abdomen and the femora flattened.......................... LIPOSCELLIDAE.

—. Pronotum undivided and collar-like; wings when developed with distinct and complete venation; abdomen fusiforu or sub-globular; femora normal...PACHYTROCTIDAE.

Of these families, only the genera *Psacadium* and *Peritroctis* (Menon, 1938) of the Pachytroctidae, have so far been recorded from India. In this contribution I record the genera *Tapinella* (Pachytroctidae), and *Liposcellis* and *Embidopsocus* (Liposcellidae), the genera *Tapinelia* (Pachytroctidae), and *Liposcellus* and *Embidopscoucus* (Liposcellidae).

Family LIPOSCELLIDAE

The Liposcellidae differ from the other families of the group mainly in the following characters: body dorsi-ventrally flattened. Median epicranial and the frontal sutures totally wanting. First flagellar segment onwards distinctly annulated. Eyes much reduced, with only few facets. Anterior region of the pronotum distinctly tri-lobed. Femora very much broadened, the hind ones more so. Wings well developed or totally wanting; when well developed the forewings with two indistinctly-demarcated, longitudinally-running veins only; hindwings without any venation.

This family is composed of only three genera, *viz. Liposcellis, Embidopsocus* and *Trigonoscelliscus*. These genera can be distinguished from one another by the following key :

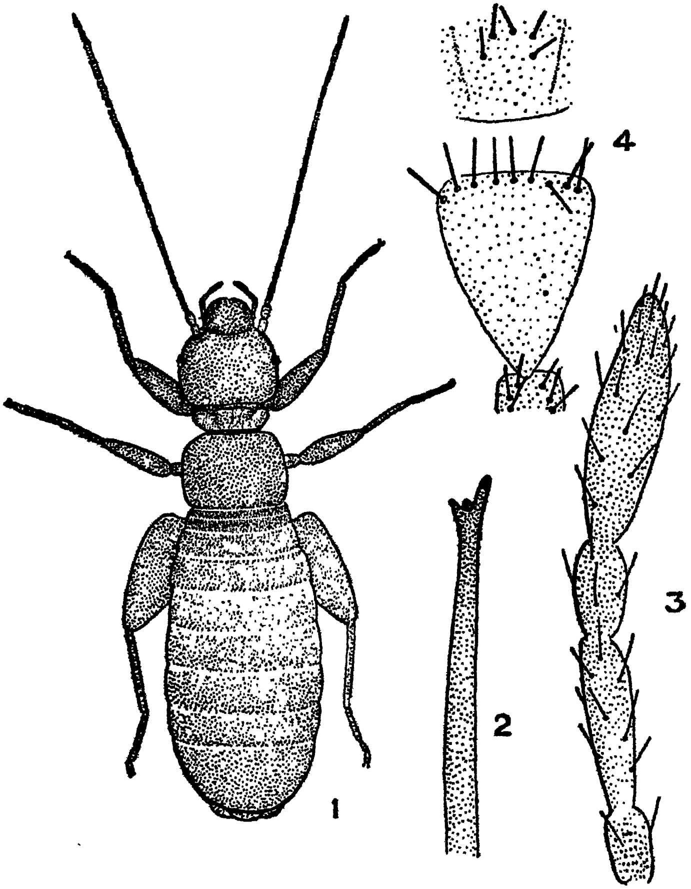
1. Abdomen very broad, with straight sides; eyes composed of only two ommatidia; maxillary palpi about 3/4 as long as the length of the head..TRIGONOSCELLISCUS.

—. Abdomen elongate-oval in outline; eyes with more than two ommatidia; maxillary palpi normal..2.

2. Hind tibiae with teeth-like projections along their outer margin; meta-tibiae with uniform-sized hairs; abdominal segments 9 and 10 completely fused; ocelli and wings unknown...LIPOSCELLIS.

—. Hind tibiae without any teeth-like projections; meta-tibiae with long bristly hairs along the outer margin besides the ordinary hairs; abdominal segments 9 and 10 separate; ocelli and wings present or totally wanting..................EMBIDOPSOCUS.

Of these three genera, *Trigonoscelliscus* is so far known only from Paraguay; *Liposcellis* is a cosmopolitan species and *Embidopsocus* has been known from America, England, and Africa.



Figs. 1-4.—*Liposcellis transvallensis* Enderl. (?)

1. Complete ♀ insect (dorsal view); 2. Maxillary 'pick'; 3. Maxillary palp; 4. Thoracic and first abdominal sterna, showing chaetotaxy.

Genus: **Liposcellis** Motschulsky.

1852. *Liposcellis* **Motschulsky,** *Etudes Ent.* P. 19-20.

Some authorities have used the name *Troctes* Burmeister instead of *Liposcellis*; it may however be mentioned that the name *Troctes* was originally used by Burmeister to include *Liposcellis* as well as *Atropos*.

The species of *Liposcellis* are separated from one another mainly by the sternal chaetotaxy.

Liposcellis transvallensis Enderl. (?).

1909. *Liposcellis transvallensis* Enderlein, G. *Stett. Ent. Zeit*, P. 272-273.

Several ♀♀ specimens. Loc.—Bombay City. Collected during various times, on books, herbarium specimens, insect-cases, etc.

Length of the body: I mm (approx.). These specimens agree with Enderlein's description of the type from Transwall. The sternal chaetotaxy is slightly variable in my specimens and therefore it is with some hesitation that I assign my specimens to Enderlein's species. Some of my specimens show six prosternal bristles and a row of ten bristles on the meso-meta-sterna, just as described by Enderlein. Many specimens on the other hand, show only five pro-sternal and nine meso-meta-sternal bristles (Fig. 4.) It is worthy of mention that Enderlein had only a single specimen before him and as such he could not note any variation.

Genus **Embidopsocus** Hag.

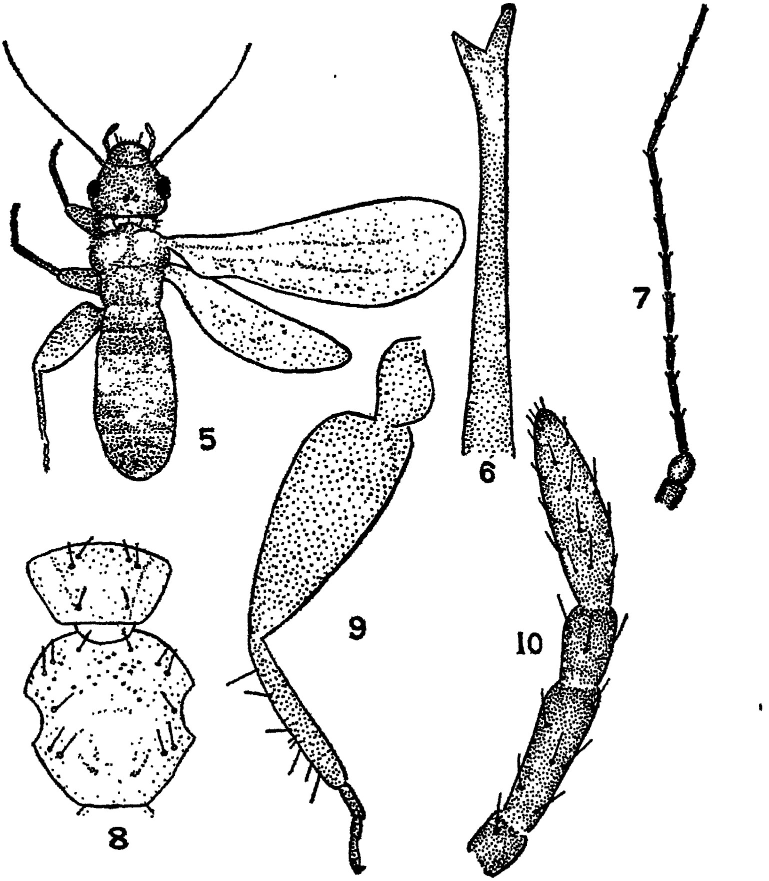
1865. *Embidopsocus.* **Hagen,** *Ent. month. May*, **2:** 171

Pearman (1935) has recently shown that the genera *Embidopsocus* Hag., *Embidotroctes* Enderl., *Stenotroctes* Enderl. and possibly *Tropusia* Hagen are synonymous. On an examination of the venation of Hagen's type of *Embidopsocus* (*E. luteus* Hag.) Pearman has found that there was a misprint in Hagen's original description and that it was due to this misprint that Enderlein had to create the genus *Embidotroctes*, to place his African *E. paradoxus*. Comparison of the venation of the two species has shown that both were identically of the same type and that the two genera were really identical. Further, Pearman's studies revealed that there is an alary dimorphism among *Embidopsocus*, and that it was only for the apterous forms of this genus that Enderlein created the genus *Stenotroctes*. My own observations on an Indian species of *Embidopsocus*, which is described below, confirm Pearman's view with regard to the identity of *Stenotroctes*. I have with me both the apterous and the alate forms, and I am sure I would have assigned the apterous forms unhesitatingly to *Stenotroctes* had it not been for the occurrence of alate individuals showing the same general characters. With regard to *Tropusia* Pearman (1935, p. 83) has written "on what is now made known, and judging from the description and figure (*1883, Stett. Ent. Zeit.* 296; 1882, t. c., fig.) it would seem that Hagen's genus *Tropusia* may not be separable from *Embidopsocus*."

Embidopsocus trichurensis, sp. n.

4 winged ♀♀ a few apterous ♀♀ and 2 apterous ♂♂ specimens. Loc.—Trichur (Cochin State). 18.iv.1935. Collected from dry leaves on the ground. Length of the body: 1·7 mm. (♀) 1·22 mm. (♂) Length of the forewings: 1·26 mm. Length of the antennae: 0·7 mm.

Winged females:—Head somewhat triangular in outline; uniformly ferruginous-brown. Median epicranial and frontal sutures wanting. Surface of the head with short, fine hairs. Vertex of the epicranium smoothly rounded. Clypeus very tumid, with short fine hairs; one hair on either side of the anterior region markedly longer than the remaining ones. Eyes small, composed of few ommatidia, one facet towards the posterior region of the eyes distinctly larger than the others. Ocelli three, moderately close together, flush with the surface of the head; the inner half of each ocellus pinkish-black and the outer half almost whitish. Antennae moderately long, fifteen-jointed; the scape and the pedicel almost bulbous; flagellar segments long, cylindrical and distinctly annulated; each flagellar segment with a few scattered bristly hairs. Maxillary 'picks' (fig. 6) sub-cylindrical; their apices produced into three distinct tines.



Figs. 5-10.—*Embidopsocus trichurensis*, sp. n.

5. Complete ♀ insect (dorsal view, Legs and wings of one side not shown); 6. Maxillary 'pick'; 7. Antenna; 8. Thoracic sterna showing chaetotaxy; 9. Meta-thoracic leg; 10. Maxillary palp.

Maxillary palpi (fig. 10) four-jointed, ferruginous-brown; last segment elongate-oval, somewhat tapering to a blunt tip; segments with bristly hairs.

Thorax ferruginous-brown. Pronotum visible dorsally, narrow: its anterior margin divided into three lobes. a middle broad antedorsum and two lateral dorsal plates; the antedorsum separated into two lateral halves by a median longitudinal groove; the antero-lateral corner of each dorsal plate well rounded and bearing three short setae. The alinota with the characteristic sutures of winged psocids; the dorsum of both with a faintly-marked median suture; the anterior margin of the mesonotum almost semicircular and slightly overlapping the posterior part of the pronotum. Thoracic sterna (Fig.8) well developed, the prosternum somewhat broadly trapezoid, with two oblique grooves and three pairs of setae; the meso and the meta-sterna fused together, to form a single plate and bearing six pairs of setae. Wings well developed Forewings smoky hyaline, narrow at their bases and broader towards the tips, with the apical margin well rounded, with only two faintly-demarcated longitudinally-running veins. Hindwings narrower and somewhat tapering towards their tips. Membrane of both wings minutely punctate, devoid of any hairs. Legs (Fig. 9) yellowish brown, the tarsi and the claws lighter in colour. Femora flattened, the hind ones more so. Throchanters short and fused with the femora. Hind tibiae with a few long bristles of unequal size along their outer margin besides the ordinary fine hairs. Tarsi three-jointed Hind tarsi almost in the ratio 2:1:2. Claws with a distinct preapical tooth.

Abdomen elongate-oval in outline, dorso-ventrally flattened, yellowish-brown; segments seven to ten bearing bristly hairs of unequal size. Paraprocts and telson reduced in size; the former without any distinct sense-field or trichobothria.

Apterous females:—Resemble the alate ones to a remarkable extent, but can be readily separated by the absence of ocelli and wings. Further, they have comparatively smaller eyes (1.0.9: 1)* with fewer ommatidia.

Apterous males:—Have the same general characters as the females but are smaller, possess smaller eyes (1.0.13:1) and have a lighter colouration. They are also, like the apterous females, devoid of wings and ocelli. Besides, they possess transverse rows of very long bristly hairs on the ventral surface of the abdomen, towards the tip; the number of bristles in each row appear to be variable.

Pearman has pointed out (in *lit*) that my specimens might possibly be identical with ***Tropusia oleagina*** recorded by Hagen from Ceylon. But, after a comparison with Hagen's figures, for a copy of which I am highly indebted to Pearman, I am unable to agree with him. My specimens differ distinctly from ***Tropusia oleagina*** in the shape of the prothorax and that of the maxillary 'picks' and in the absence of denticles on the claws and of the anal hooks.

The number of meso-meta-sternal bristles in my specimens agree somewhat with that of ***Embidopsocus*** (*Stenotroctes*) ***needhami*** (ENDERLEIN, 1905.pl.3.f.30), but in that there are two short fine hairs towards the base and an extra bristle on the left side which are absent in my specimens. Further, in my specimens there are three pairs of pro-sternal bristles, whereas in Enderlein's figure he has shown only two pairs. Besides, my specimens are smaller in size than the specimens of Enderlein. Again, *E. needhami* has been recorded only from Africa. I, therefore, regard my specimens as quite distinct from those of Enderlein.

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* 1...0. is used after Pearman [vide: *Stylops*, 3 (6): 121, 1934.]

Family PACHYTROCTIDAE *

The following characters are noteworthy: Median epicranial suture quite distinct. Eyes subspherical, with comparatively more facets. Ocelli present only in winged forms, three in number and forming a small equilateral triangle. Antennae relatively longer than the body; the first few flagellor segments without rings, the distal ones distinctly annulated. Pronotum narrow, undivided and collar-like. Alinota undivided (apterous forms) or divided by the characteristic sutures of winged psocids (alate forms). Wings well developed or totally wanting; some species showing a distinct alary dimorphism. Wings narrow, with the apices well rounded; venation distinct; stigmasac wanting; pterostigma undifferentiated; rs and m, both only once forked in forewings; areola postica narrow, sub-rectangular and lying somewhat parallel to the hind margin of the wings; cu_2 and la having separate endings on the wing margin; cu_2 fused with $m+cu_1$ at the wing-base. Hindwings without a closed basal cell. Legs long and slender; femora normal. Trochanteral setae present. Abdomen fusiform or sub-spherical.

The Pachytroctidae, according to the opinion of Pearman (in lit), are divisible into two subfamilies. These may be separated out by the following key:

1. Eyes with groups of rod-like hairs arranged in combs between the facets; rs and m of the forewings fused over a stretch; abdomen sub-globular....... .... PERITROCTINAE.

—. Eyes bare; rs and m of the forewings connected by a crossvein; abdomen long and fusiform ....PACHYTROCTINAE.

Subfamily PERITROCTINAE

This subfamily is represented by the genus *Peritroctes*; possibly *Nymphotroctes* also belongs to this subfamily.

Genus **Peritroctes** Rib.

1911, *Peritroctes*, **Ribaga,** *Redia*, vii. 156-171, figs. 5 & 6

This genus is at present known by only two species, the genotype, *P. natalensis* Ribaga (1911), recorded from Natal (Africa) and *P. cochinenis* Menon (1938), from Cochin State (India). The African species is known in the apterous form only, whereas the Indian species is known in both the apterous and the alate forms.

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* Since the preparation of this paper I have come across Rosler's contribution [*Zool. Anz.*, **129** (9/10): 225-243. 1940] wherein he distinguishes the subfamilies Tapinellinae and Pachytroctinae. In the light of the occurrence of alary dimorphism in some genera of this family I have already shown [*Proc. Indian Acad. Sci.*, **8** (4): 286. 1938] the recognition of these subfamilies would lead to the assignment of winged forms of a particular species to the Tapinellinae and wingless forms of the same species to the Pachytroctinae. From a careful comparison of the descriptions of *Psyllotroctes plaumani* Rosler and *Pachytroctes brasilianus* Rosler I am afraid this veryerror has been committed by Rosler. The close similarity between these two, corroborated with the fact that both these have been collected from the same locality about the same time by the same collector lead me to beleive that possibly *Psyllotroctes plaumani* Rosler is nothing but the winged form of *Pachytroctes brasilianus* Rosler! If this be so the generic name *Psyllotroctes* should become a synonym of *Pachytroctes* and Rosler's species should be known as *Pacytroctes plaumani* (Rosler).

Peritroctes cochinensis Menon.

1938. *Peritroctes cochinensis* Menon, *Proc. Indian Acad Sci.* (B) **8** (4):

The Indian species differs from the genotype mainly by the peculiar form of the head and the darker colouration.

Subfamily PACHYTROCTINAE.

The Pachytroctinae are composed of the genera *Tapinella, Psylloneura, Pachytroctis, Psacadium, Nanopsocus, Paleotroctes,* and *Cuixa* (?). Of these, *Paleotroctes* has been recorded as fossil in Baltic amber.

The pachytroctinae have been known from India only by the genus *Psacadium*. In this contribution I am able to record *Tapinella* also from this country.

Genus **Psacadium** Enderl.

1908. *Psacadium,* **Enderlein, G.,** *Zool. Anzeig*, **33.**

The genus *Psacadium* differs from all the other genera of Pachytroctinae mainly in having very long and thin antennae. Winged forms with first segment of sc wanting in the forewings, r_1 present in the hindwings and the membrane of both wings minutely punctate.

This genus is at present known only by two species, *viz., P. bilimbatum* Enderl., the genotype, recorded from Formosa and *P. georgi* Menon, from Cochin State (India.)

Psacadium georgi Menon.

1938. *Psacadium georgi,* **Menon, R.,** *Proc. Ind. Acad. Sci.,* (B) **8(4)** 280-283.

The Indian species can be readily distinguished from the genotype, *P. bilimbatum* Enderl, by its more or less uniform ferruginous colouration, with a transverse band of creamy-yellow over the segments three to five of the abdomen. *P. bilimbatum* is whitish-to ochreaceous-yellow, with broad brownish bands running longitudinally along either side of the body.

This species was originally recorded from Cochin State. I have it now from Bombay also.

Genus **Tapinella** Enderl.

1908. *Tapinella,* **Enderlein, G.** *Zool. Anzeig.,* **33.**

This genus differs from *Psacadium* by the shorter antennae and the close-set rod-shaped microtrichia of the wings; further, first segment of sc which is absent in *Psacadium* is usually present in the forewings; in the hindwings r_1 is wanting.

In this connection I wish to point out that *Psylloneura williamsi* Banks (1931) appears to belong to the genus *Tapinella,* since r_1 is not present in the hindwings of that species. In *Psylloneura,* r_1 is present and forms a distinct vein (Enderlein 1903).

Tapinella has not been recorded from India. But, I have one species of this genus in my collection *viz.*, *Tapinella formosana* Enderl.

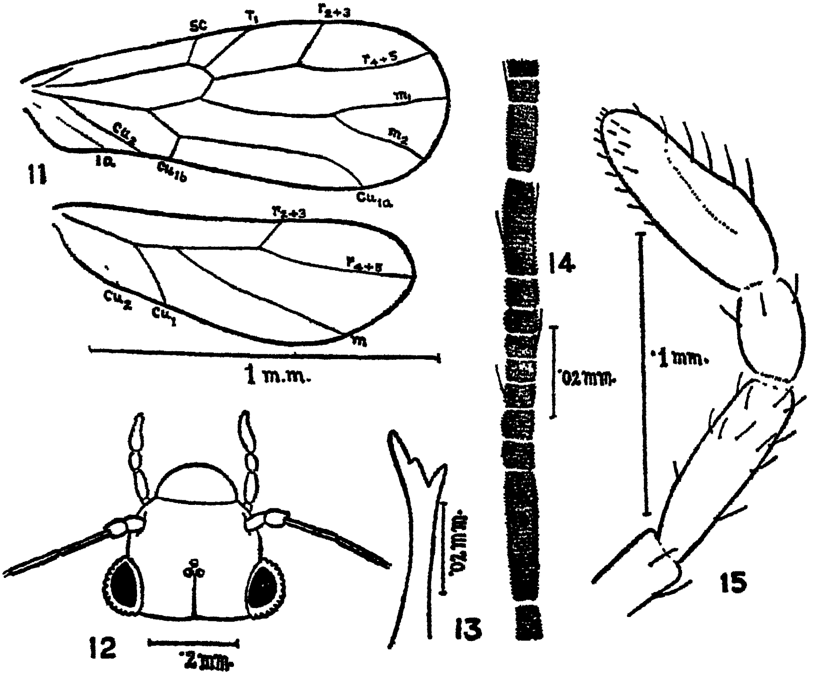
Tapinella formosana Enderl.

1908. *Tapinella formosana*, **Enderlein, G.** *Zool. Anzeig.*, **33** 774. fig. 1

Several ♀♀ specimens. Loc.—Bombay City and Tripunithura (Cochin State). Collected at different times. From dry foliage on ground.

Length of the body: 1.2 mm. Length of the forewings. 1.25 mm. Enderlein's description of this species is rather short. Hence, I take this opportunity to give a detailed description, based upon my specimens:

Head (Fig. 12) more or less triangular in outline, almost as broad as long, brownish yellow. Median epicranial suture distinct; frontal sutures wanting. Surface of the head bearing short fine hairs. Vertex of the epicranium smoothly rounded. Clypeus very tumid. Eyes moderately large, 1.0 4: 1 (approx.), hemispherical, situated at the hind corners of the head. Ocelli three, slightly pinkish, close together, forming a small equilateral triangle, flush with the surface of the head. Antennae fifteen-jointed; the scape and the pedicel sub-equal, short and somewhat bulbous; the flagellar segments long and cylindrical; the fifth to the last flagellar segments distinctly annulated (Fig. 14); segments with close-



Figs. 11-15—*Tapinella formosana* Enderl.

11. Wing-venation; 12. Head (dorsal view); 13. Maxillary 'pick'; 14. part of antenna showing annulations; 15. Maxillary palp.

set microtrichia and a few fine hairs at long intervals. Maxillary 'picks' (Fig. 13) sub-cylindrical, apically with three tines, of which the outer-most is the longest. Maxillary palpi (Fig. 15) four-jointed, with scattered bristly hairs, brownish-yellow; last segment elongate-oval, somewhat narrowed from the middle towards the tip.

Thorax yellowish-brown. Pronotum narrow, collar-like and undivided; visible from the dorsal aspect. Alinota well developed; mesonotum about twice as long as the metanotum; both with the characteristic sutures of winged psocids. Wings (Fig. 11) narrow at the base and broader towards the tips; the wing-apices well rounded; membrane hyaline, with smoky-yellow veins, with closeset rod-shaped microtrichia on both sides; forewing-margin with a few microscopic, fine, straight hairs, at long intervals. Forewing-venation; first segment of sc short and distinct; distal segment of sc, r_1 and r_{2+3} relatively short, straight and oblique: pedicel of the radial forks about two-third as long as r_{4+5}; rs and m connected by a short cross-vein; m_1 and the pedicel of the median forks subequal; cu_1 a long and running almost parallel to the hind margin of the wings; cu_2 and la having separate ending on the wing-margin; la rather faintly demarcated. Hindwingvenation: r, m, and cu fused together from the wing-base to form a main stem-vein from which their distal parts take off; r_{4+5} long and more or less straight; m relatively long; r_1 absent. Legs long and slender; light yellowish-brown. Trochanteral setae present. Tarsi three-jointed. Hind tarsi in the ratio 13:4:4. Ctenidia wanting. Claws straight and slender, with a distinct preapical tooth.

Abdomen somewhat fusiform, creamy-yellow. Paraprocts reduced in size, without any sense-field or trichobothria. Subgenital plate of the female with rounded posterior margin, beset with uniform-sized, short, bristly hairs; with a distinct large chitinised T-shaped area on the inner side.

Group PSOCATROPETAE.

Small to comparatively large psocids, clothed with long shaggy hairs.

Head sub-triangular, or more or less broadly oval, in outline. Median epicranial suture distinct; frontal sutures wanting. Vertex of the epicranium smoothly rounded. Surface of the head with moderately close-set, long, shaggy hairs. Eyes small or large, with a varying number of ommatidia; the cornea without hairs. Ocelli three, rather wide apart, forming a small triangle, flush with the surface of the head. Antennae long, slender and fragile; the scape and the pedicel short and stout: flagellar segments many in number, long and cylindrical; each segment bearing a few bristly hairs, sometimes with annulations. Maxillary 'picks' sub-cylindrical, apically produced into three distinct tines. Maxillary palpi four-jointed; the first and the third segments short, the second and the fourth much longer than any of these; all segments with uniform-sized hairs; second segment without any sense-spur: last segment hatchet-shaped. Labial palpi distinctly two-jointed.

Pronotum narrow and collar-like; in brachypterous forms better seen from the dorsal aspect. Alinota with the characteristic sutures of winged psocids. Wings well developed or reduced; the wing-margins broadly chitinised, sometimes with a pattern of rows of elongated pits (Psyllipsocinae); membrane of both wings minutely punctate; hairs present usually on the veins as well as margin; pterostigma and stigmasac not well demarcated; venation variable according to the amount of reduction in the size of wings; in the normally developed forewings; rs once forked, m with the usual three branches, cu_1 forked, the forks relatively long and straight; cu_1a only slightly curved (never arched), cu_2 and 1a ending together in a nodulus on the wing-margin. In the normally developed hindwings: m forked and the branches arising from a common pedicel. Legs long and slender. Meso-coxae with or without inter-locking device. Hind-coxae with small stridulatory areas. Tibiae long and cylindrical, bearing several short spinous bristles besides the ordinary hairs. Tarsi three-jointed. Ctenidia wanting Claws with or without preapical teeth.

Abdomen somewhat fusiform. Both the subgenital plate of the female and the hypandrium of the male large, simple and somewhat hood-like. Outer gonopods of the ninth segment of the female large and broad, bearing several long bristles; the inner gonopods reduced and membranous, without bristles.

Pearman has recognised two divisions under this Group, *viz.*, Scoliopsocida and Psocatropida.

Division *SCOLIOPSOCIDA*

The Scoliopsocida comprise the family Scoliopsyllopsidae, which contains only one known genus, viz, *Scoliopsyllopsis*. The genus is at present known only by one species *S. laterielli* Enderlein (1912) found living inside caves in France. This is a comparatively large species, fully developed ones having a forewing-length of 5·7 mm. and a body-length of 4 mm. (Enderl. 1915. p. 49). Recently, Ball (1936) has shown that *Scoliopsyllopsis* is identical with *Prionoglaris* Ederlein (1909) and what was described by Enderlein as *Prionoglaris stygea* (Genotype) is only the nymphal form of *Scoliopsyllopsis latreilli*.

Division *PSOCATROPIDA*

Consisting of comparatively small psocids, having a body length of about 1½ mm. Adults show variations in the wing-development, but never totally apterous. Other characters as given for the group.

Under this division only one family, the Psocatropidae, has been recognised by Pearman.

Family PSOCATROPIDAE

Characters of the family as given for the division.

The Psocatropidae comprise the genera *Psocatropos* Ribaga (1911), *Dorypteryx* Aaron (1883), *Psyllipsocus* Selys Longchamps (1872), *Parempheria* Enderlein (1906) and *Volturops* Townsend (1912). The differences in the structural make-up of these genera necessitate a division into two subfamilies as follows:

1. Relatively smaller forms. with acute wings-tips; wing-margins chitinised, but without any distinct pattern; eyes small, with fewer factes, somewhat morruliform; Antennae with many segments (abovt fifty); meso-coxae with inter-locking arrangement ....PSOCATROPINAE.

Relatively larger forms. with well rounded wing-tips; wing-margins chitinised, with a distinct pattern of rows of elongated pits; eyes large. with more facets, elongate oval in outline; antennae with relatively fewer segments, the flagellar segments annulated; meso-coxae without inter-locking arrangement...PSYLLIPSOCINAE.

Subfamily PSOCATROPINAE

The Subfamily is typically represented by the genus *Psocatropos*. *Dorypteryx* and probably *Volturops* also belong to the psocatropinae.

So far, I have been able to collect only the genus *Psocatropos* from India.

Genus **Psocatropos** Rib.

1901, *Psocatropos*, Ribaga, *Rev. Patol. Veg.*, **8**: 156—157.
1903, *Axinopsocus*, Enderlein, *Zool. jahrb.*, **19** (1): 2—3.
1931, *Gambrella*, Enderlein, *Trans. Linn Soc. Londno*, **19** (2): 221.
?. 1900, *Psocinella*, Banks, *Ent. News*, p. 431.

Psocatropos can be readily distinguished from the other two genera by the relatively broader wings with more complete venation. Wings, even when fully developed, hardly extend beyond the abdomen. Body-form somewhat peculiar, the head and the thorax together making an angle with the abdomen and thus presenting some sort of humped appearance. The head, thorax and the margins and veins of the wings, bearing long, shaggy hairs. Meso-coxae with inter-locking device. Meta-coxal stridulatory area very small and bearing prominent teeth.

Enderlein (1908) has shown that *Axinopsocus* Enderl. (1903 a) is synonymous with *Psocatropos*. He regarded *Psocinella* also as identical with this genus; but Banks (1929), in his classification of psocids, has pointed out that *Psocinella* differs from *Psocatropos* in the relative lengths of the hind femora. How far this character alone should be looked upon as of generic significance is yet open to question.

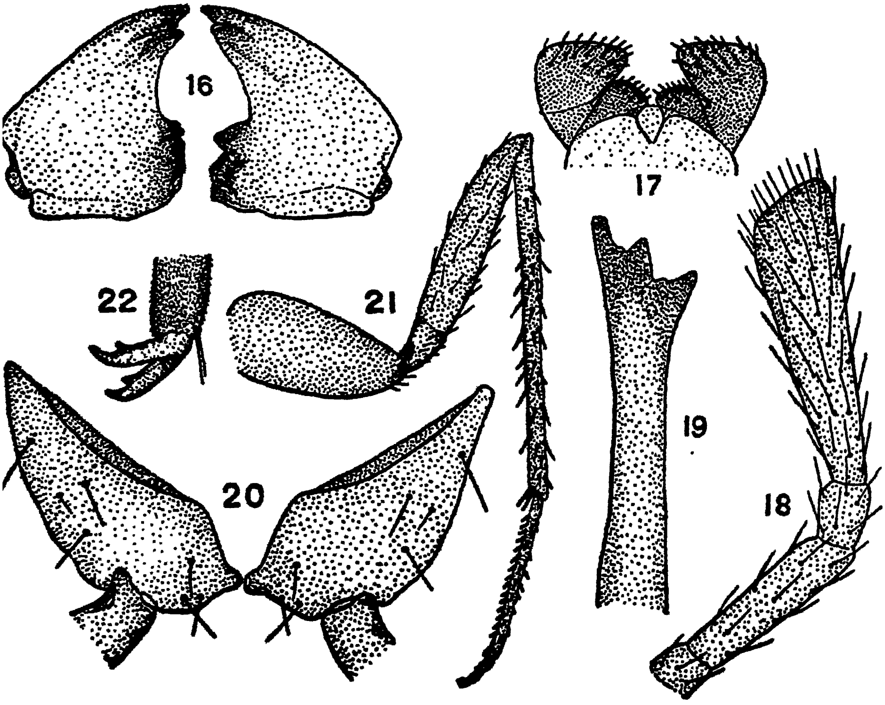
The genus *Gambrella* was erected by Enderlein for a single specimen of *G. pilipennis* from Seychelles. From Enderlein's description the only difference I note between the genera *Psocatropos* and *Gambrella* is the presence of an r_1-rs cross-vein in the latter. I have several specimens agreeing in all details with Enderlein's *Gambrella pilipennis*; though most of them show exactly the same type of forewing-venation as noted and figured by Enderlein, venational variations are not uncommon. Among them several specimens show the type of venation characteristic of *Psocatropos*. I, therefore, do not hesitate to regard *Gambrella* also as identical with *Psocatropos*.

Psocatropos pilipennis (Enderl.)

1931, *Grambrella pilipennis*, Enderlein, G.—*Trans. Linn. Soc. London*, pp. 221-222. Fig. 6.

Several specimens (♂♂ & ♀♀). Loc.—Bombay City. Commonly found living on the crevices of walls inside houses. Length of the body: 1·1—1·4 mm. Length of the forewings: 1 mm (approx. variable). Head broadly oval in outline, light yellowish-brown. Median epicranial and the frontal sutures not clearly demarcated. Surface of the head bearing moderately close-set long shaggy hairs. Vertex of the epicranium smoothly rounded. Eyes relatively small, somewhat morruliform, deep brownish-black, bare. Ocelli three, reddish-brown, close together, flush with the surface of the head. Antennae long, many-jointed, very fragile; the scape and the pedicel short and stout; flagellar segments long and cylindrical, progressivelly shorter towards the tip. Maxillary 'picks' (Fig. 19) sub-cylindrical, apically produced into four tines and short denticles between them. Maxillary palpi (Fig. 18) four-jointed; last segment long and hatchet-shaped; all segments bearing bristly hairs of uniform size.

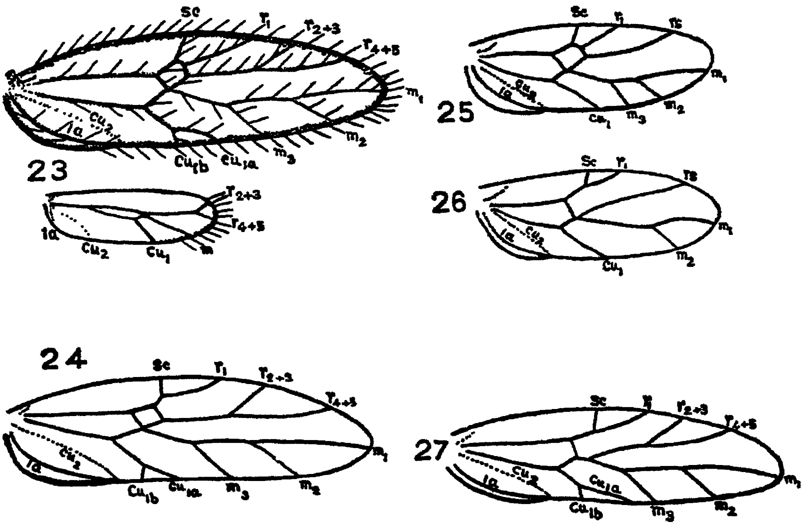
Thorax yellowish-brown. Pronotum very much reduced; in fully-winged forms, hardly visible from the dorsal aspect. Alinota narrow and undivided (brachypterous forms) or with the characteristic sutures of winged psocids (fully-winged forms). Wings with broad bases and narrowed tips, with the apices bluntly acute; different individuals showing grades of wing-development (brachyptery) and consequently venational variations (Figs. 24-27). Wing-margins well chitinised, bearing one series of long shaggy hairs; all veins of forewings, exeept cu_2, also bearing one series of hairs; only the apical margin of the hindwings bearing hairs. Hindwings much reduced or totally wanting. Venation: in the normally developed wings (Fig. 23) distal segment of sc short and straight, stigmasac wanting, pterostigma undifferentitated, r_1 relatively long and straight, rs forked, r_1 and rs connected by a cross-vein, rs and m meeting at a point or fused over a very short stretch; m three-branched, cu_1 forked, the forks running rather straight, cu_2 and la ending together in a nodulus. Among variations the following are note-worthy: distal segment of sc and r_1 apparently arising from a common pedicel, rs simple, m only once forked and cu_1 simple. Legs (Fig. 21) rather long and slender, light yellowish brown. Femora slightly flattened. Meso-coxae (Fig. 20) with inter-locking device. Meta-coxae with small



Figs. 16-22.—*Psocatropos pilipennis* (Enderl.)

16. Mandibles; 17. Labium; 18. Maxillary palp; 19. Maxillary 'Pick'; 20. Meso-coxae; 21. Meta-thoracic leg; 22. Claws.

stridulatory areas composed of a few prominent teeth. Tibiae long and cylindrical, bearing short spine-like bristles. Tarsi three-jointed. Hind tarsi in the ratio 5½ : 1 : 1. Ctenidia wanting. Claws (Fig. 22) with a distinct preapical tooth.



Figs. 23-27. *Psocatropos pilipennis* (Enderl.).
23. Normal wing venation; 24-27. Venational variations in forewings.

Abdomen yellowish-brown, with brownish mottling, held at an angle to the head and thorax so that the animal appears somewhat humped. Paraprocts with a distinct 'appendix analis', without any sense-field. The hypandrium of the male (Fig. 28) and the subgenital plate of the female large, simple and somewhat hood-like. Gonopods of the ninth segment of the female (Fig. 29) composed of two valves; the outer valve broad and bearing several bristles as figured; the inner valves narrow, blunt and membranous.

Subfamily PSYLLIPSOCINAE

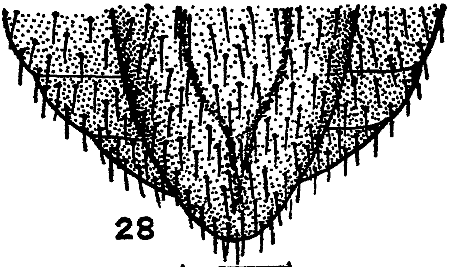
The Psyllipsocinae comprise the genera *Psyllipsocus*, at present known from Europe (England, Germany and France) only, and *Parempheria*, recorded from the Oriental region (Formosa, Japan and the Hawaiian Islands). From the descriptions of these two genera, it is rather difficult to distuinguish one from the other. The only difference, as far as I can make out between the two, lies in the nature of the marginal hairs on the forewings. On this basis I place my specimens collected from India under the genus *Psyllipsocus*.

Genus **Psyllipsocus** Selys.

1872, *Psyllipsocus*, Selys Longchamps, *Ent, Month. Mag.*, 9, P. 145.

Psyllipsocus is separated from *Parempheria* by the nature of the marginal pubescence on the forewings. In the former there are only a few hairs in a single row, whereas in the latter the forewing-margins are densely pubescent with the hairs arranged in many rows.

Psyllipsocus has not been previously recorded from this country. But, I have in my collection, two species belonging to this genus, both of them distinct from the genotype, *Psyllipsocus ramburi* Selys.



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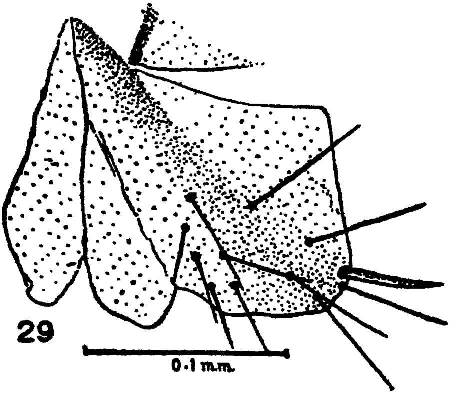

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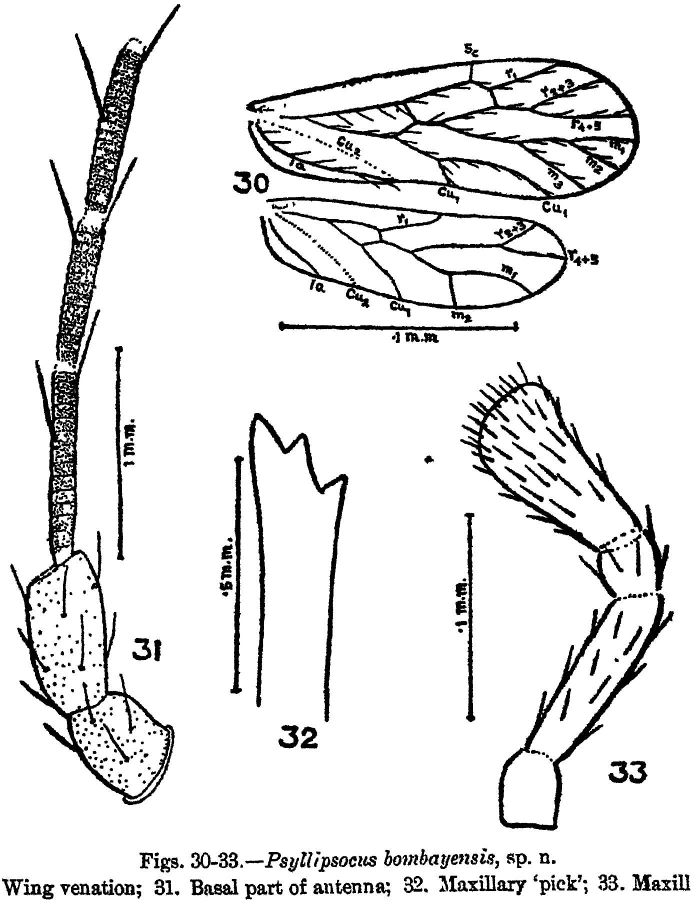
Figs. 28-29.—*Psocatropos pilipennis* (Enderl.).

28. Ventral view of the tip of ♂ abdomen showing the hypandrium; 29. ♀ gonopods.

Psyllipsocus bombayensis, sp. n.

4 specimens. Loc.—Bombay city. Collected at different times from walls inside houses while at rest. Length of the body: 1·4 mm. Length of the forewings: 1·49 mm. Head somewhat triangular in outline, with the hind corners well rounded, yellowish-brown. Median epicranial suture distinct; frontal sutures wanting. Surface of the head bearing long, shaggy hairs. Vertex of the epicranium smoothly rounded. Eyes large, 1.0.3 : 1, elongate-oval in outline, extending as far as the hind corners of the head, brownish-black with creamy-yellow facets; the cornea devoid of any hairs. Ocelli three, ferruginous-brown, rather apart and forming a small equilateral triangle, flush with the surface of the head. Antennae many-jointed, long and very fragile; the scape and the pedicel short and stout, the latter about twice as long as the former; the flagellar segments (Fig. 31) long, cylindrical and annulated, the joints somewhat lighter in colour. Maxillary 'picks' (Fig. 32) sub-cylindrical, apically produced into three tines. Maxillary palpi (Fig. 33) four-jointed, yellowish-brown, terminal-segment long and somewhat hatchet-shaped; segments bearing scattered fine long hairs

Thorax yellowish-brown. Pronotum reduced and not clearly visible from the dorsal aspect. Alinota with the characteristic sutures of winged psocids. Mesonotum bearing long shaggy hairs. Metanotum bare. Wings (Fig. 30) well developed in all the specimens collected; membrane of both pairs hyaline; veins yellowish-brown; margins well chitinised, with a distinct pattern of rows of elongated pits; forewings with a few scattered hairs along the margin as well as the veins; hindwings without hairs. Forewing-venation: distal segment of sc is rather short and runs almost perpendicular to the costal margin; r_1 straight and nearly three times as long as distal segment of sc, connected with rs by a short cross-vein dividing the cell R_1 into two, a basal $1R_1$ and a distal $2R_1$; $1R_1$ about $2\frac{1}{2}$ to 3 times as long as broad; rs and m fused over a stretch; cu_{1a} from $4\frac{1}{2}$ to 5 times as long as cu_{1b}; cu_2 and la ending together in a nodulus on the wing-margin. Hindwing-venation: r_1 leaves r before it meets m, rs and m fused over a stretch; pedicel of the radial forks much longer than r_4+_5; m forked, m_2 and the pedicel of the median forks sub-equal, and m_1 about twice



Figs. 30-33.—*Psyllipsocus bombayensis*, sp. n.
30. Wing venation; 31. Basal part of antenna; 32. Maxillary 'pick'; 33. Maxillary palp.

as long as any of these; cu$_2$ faintly demarcated. Legs long and slender, yellowish brown. Meso-coxae without any inter-locking device. Tibiae and the first tarsal segments of all legs bearing short spines besides ordinary hairs. Tarsi three-jointed. Ctenidia wanting. Hind tarsi in the ratio 14:3:3. Claws with a distinct preapical tooth.

Abdomen somewhat fusiform, yellowish-brown. Telson sub-triangular. Paraprocts with a stout and distinct 'appendix analis'. Outer gonopods of the ninth segment of the female (Fig 34) broad and sub-triangular, with rounded apices, bearing several long, bristly hairs; the inner gonopods poorly developed and weekly chitinised.

This species differs from *Psyllipsocus ramburi* Selys, mainly in size and venation. *P. ramburi* has a wing-length of 2¼ mm, whereas my specimens are definitely smaller, having a wing-length of only about 1½ mm. Further, in all my specimens there is present an r_1-rs cross-vein which occurs in *P. ramburi* only as an abberation, distal segment of sc is short and straight, and r_1 starts off from rs before it meets m.

Psyllipsocus edentulus, sp. n.

1 ♂ specimen. Loc.—Bombay city. 2.ii.1935. Collected from wall while at rest.

Length of the body 1·43 mm. Length of the forewings 1·49 mm. Head more or less triangular, with the angles well rounded, deep yellowish-brown. Median epicranial suture distinct; frontal sutures wanting. Surface of the head with scattered long, shaggy hairs. Vertex of the epicranium smoothly

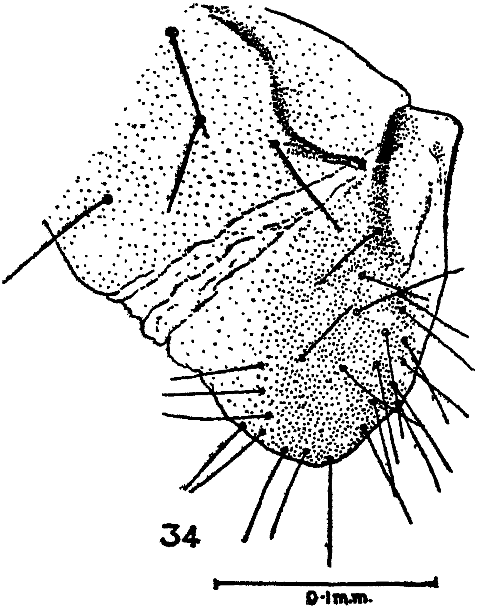
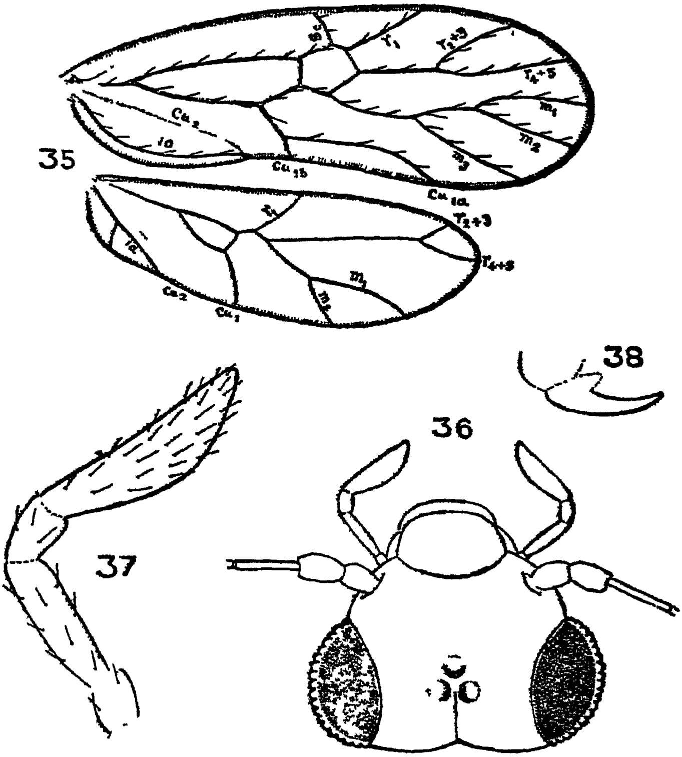


Fig. 34.—*Psyllipsocus bombayensis*, sp. n. ♀ gonopods.

rounded. Eyes large, forming a smooth curve with the hind angles of the head, 1 0.2½ : 1, brownish-black, devoid of hairs. Ocelli three, close together, relatively large, forming a small equilateral triangle, flush with the surface of the head, pinkish-brown along their inner halves and margins. Antennae long, many-jointed and very fragile; the scape and the pedicel shorter and stouter than the flagellar segments, the latter slightly longer than the former; the flagellar segments long and cylindrical, bearing a few scattered, bristly hairs. Maxillary 'picks' sub-cylindrical, apically produced into two tines, the inner one of which is smaller than the outer. Maxillary palpi (Fig. 37) four-jointed, terminal segment with a more or less straight outer and semi-circularly-curved inner margins as figured, all segments bearing bristly hairs.

Pronotum reduced and not visible dorsally. Alinota well developed, dark yellowish-brown, with the characteristic sutures of winged psocids. Mesonotum bearing scattered long, bristly hairs. Metanotum bare. Wings (Fig. 35) well developed; membrane of both wings hyaline; veins yellowish-brown; wing-margins as in the preceeding species, broadly chitinised and with a distinct pattern of several rows of elongated pits; veins of the forewings bearing scattered long,fine hairs; margins of both wings with a few short, blunt, microscopic



Figs. 35-38.—*Psyllipsocus edentulus*, sp. n.
35. Wing venation; 36. Head (dorsal view); 37. Maxillary palp; 38. claw.

spines. Forewing-venation: distal segment of sc curved and directed towards the wing-base; r_1-rs cros-vein present, short and somewhat oblique; $1R_1$ almost as long as broad; rs and m normal; areola postica much longer and narrower than in the above-described species; cu_2 and la ending together in a nodulus. Hindwing-venation: r_1 takes off after the meeting of rs and m, the pedicel of the radial forks comparatively very long and the branches short; the pedicel of the median forks shorter than the branches; cu_1 relatively short and running almost vertically downwards; la forked as in *Scoliopsyllopsis latreilli* Enderl. Legs rather long and slender, yellowish-brown. Femora slightly flattened. Tibiae and first tarsus of all legs bearing spur-like hairs. Tarsi three-jointed. Ctenidia wanting. Claws (Fig 38) more or less straight, without any preapical tooth.

Abdomen somewhat fusiform, yellowish-brown, with ferruginous-brown mottling along the sides. Paraprocts with a sense-field consisting of five trichobothria of which the central one is distinctly stouter than the remaining ones, Telson sub-triangular, with broadly rounded tip.

This species can be readily distinguished by the nature of the terminal segment of the maxillary palpi, the forked la in the hindwings and the absence of the preapical tooth from the claws. It is remarkable that the last two features it shares with *Scoliopsyllopsis latreilli* Enderl, but unlike that species sc is distinctly broken up in the forewings and in the hindwings r_2 becomes free only after the meeting of r and m. Further, *Scoliopsyllopsis latreilli* is a relatively very large species.

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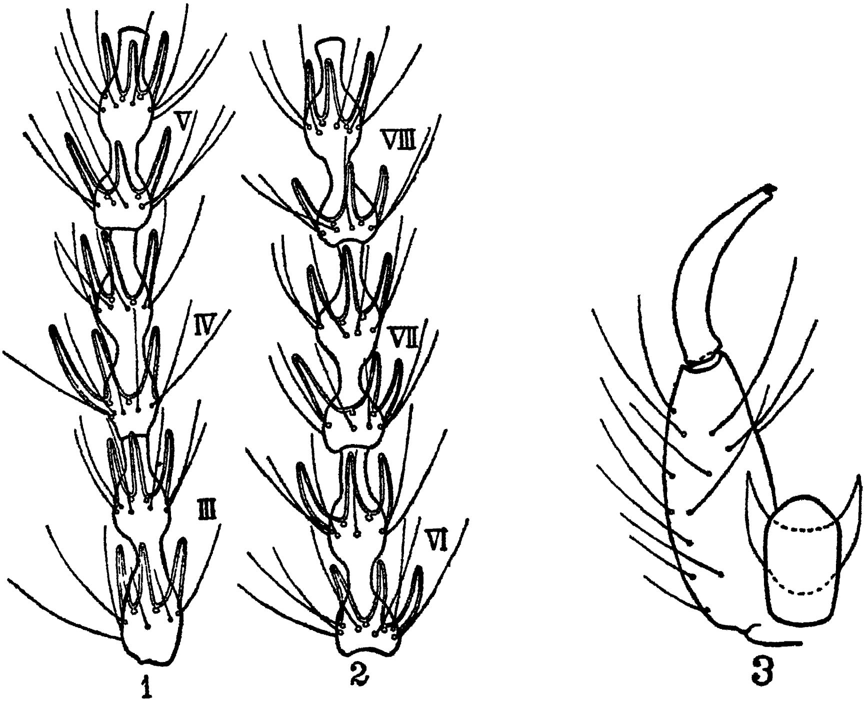
STUDIES ON INDIAN ITONIDIDAE (CECIDOMYIDAE: DIPTERA)

VI.—DESCRIPTIONS OF NEW MIDGES AND GALLS*

By M. S. MANI, *Assistant to the Imperial Entomologist, New Delhi.*

This is an account of my recent studies on some gall-midges and their galls, received by the Imperial Entomologist for identification from the Forest Entomologist, Dehra Dun. Descriptions of two other forms in the Imperial Pusa collection are also included here. The types of the new genera and species described here are deposited in the Imperial Pusa Collection, Laboratory of the Imperial Entomologist, Imperial Agricultural Research Institute, New Delhi.

Subfamily ITONIDIDINAE
Tribe *ITONIDIDINARIAE*
Subtribe BIFILA
Contarinia dalbergiae, sp. nov.



Figs. 1-3.—*Contarinia dalbergiae*, sp. nov.
1-2. Flagellate antennal segments third to eighth of male; 3. Male genitalia (one half).

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* Parts I-V of these studies were published in *Rec. Indian Mus.*, respectively in 1934, 1935, 1936, 1937 and 1938.

Male.—0.75 mm. long. Brown. Palpi: all the four segments subequal in length. Antennae dark brown, about two and a half times the length of body; third, fourth, fifth, sixth, seventh and eighth antennal segments as shown in figures 1, 2. Wing as in figure 4. Claw weakly bent; empodium short. Genitalia as in figure 3 Abdomen black.

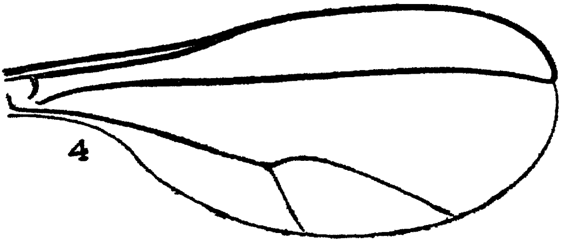

Fig. 4.—*Contarinia dalbergiae*, sp. nov , wing.

Female.—1.0 mm. long. Brown in carded specimens. Mesonotum black. Antennae half the length of body. Ovipositor about twice the length of body.

Holotype one male, allotype one female, dissected on slides. Described from a series of specimens received from the Forest Entomologist, Dehra Dun, labelled: "bred from *shisham* flower buds, Dehra Dun, P. N. Chatterjee, 11-24 iv.1941."

This species differs from the two other species of *Contarinia* Rondani, so far known from India, in the extremely short empodium of claw and in the host plant.

Sissudiplosis, gen. nov.

Palpi uniarticulate. Antennae with 14 segments, all the flagellate segments binodose in male: circumfila loops almost equal to stems of segments in male. Eyes not separated. Wings spotted as in figure 10; third vein uniting with margin at apex. Claws simple on all legs. Male genitalia as in figure 8: dorsal plate shorter than ventral plate, broadly divided; ventral plate deeply cleft; basal clasp segment as in figure; terminal clasp segment with one tooth apically. Ovipositor long.

This is the only genus of the subtribe Bifila with uniariticulate palpi, simple claws and all the flagellate segments binodose in male.

Genotype.—*Sissudiplosis chatterjeei*, sp. nov.

Sissudiplosis chatterjeei, sp nov.

Male.—1·25 mm. long. Yellowish-brown. Palpus as shown in figure 5. Third, fourth, fifth and fourteenth antennal segments as in figure 6; antennae a little longer than body. Claw as in figure 9, empodium almost half the length of claw. Genitalia as in figure 8, style bluntly pointed and reduced apically.

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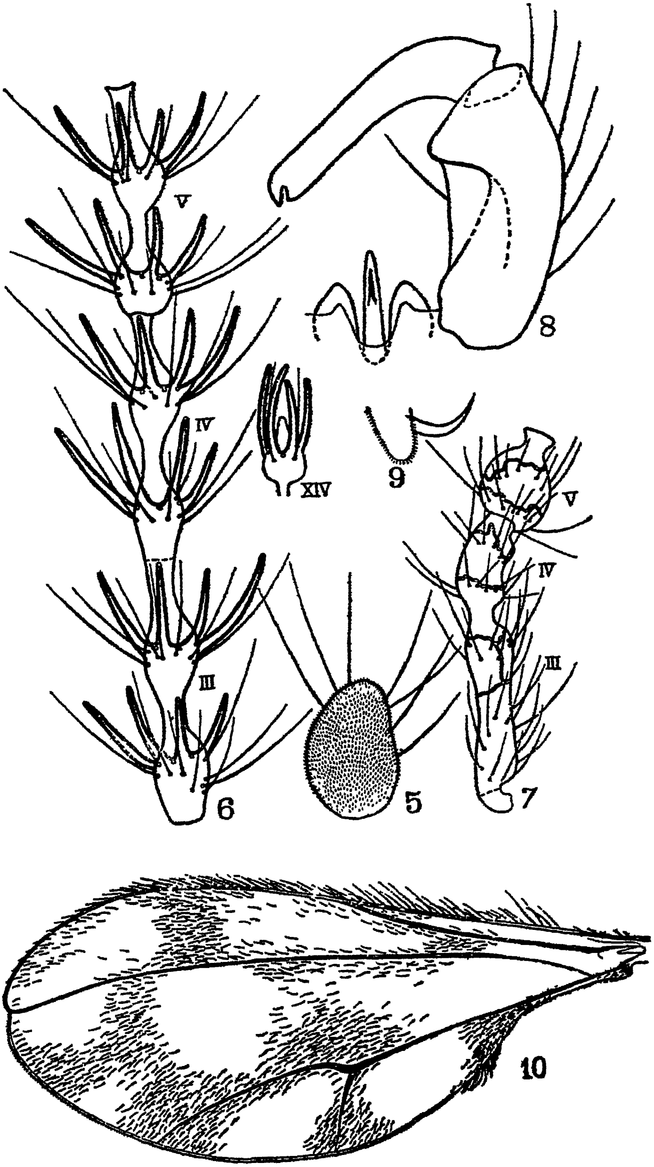
* Mani, *Rie. Indian Mus.*, 1934.



Figs. 5-10.—*Sissudiplosis chatterjeei*, sp. nov.

5. Palpus; 6. Flagellate antennal segments third to fifth and fourteenth of male; 7. Flagellate antennal segments third to fifth of female; 8. Male genitalia (one half); 9. Claw; 10. Wing.

Female.—1.5 mm. long (excluding the ovipositor), yellow. Mesonotum brown. Third, fourth and fifth antennal segments as in figure 7. Otherwise as in male.

Holotype one male, allotype one female on slides Described from a series of specimens received from the Forest Entomologist, Dehra Dun, labelled: "bred from leaf of *sisham*, Dehra Dun, P. N. Chatterjee, 5-10 iv 1941."

Subtribe TRIFILA

Pipaldiplosis, gen. nov.

Palpi triarticulate. Antennea with 14 segments, all the segments of flagellum binodose, enlargements and stems short, circumfila in three whorls, the second whorl of very short loops, first and third whorls with the loops relatively longer, but equal to the stems of the respective enlargements; setae moderately long. Eyes not separated. Wing hyaline, as in figure 14; third vein reaching margin at apex. Claws simple on all legs, short. Genitalia: dorsal plate broad, truncate apically; ventral plate very deeply cleft, one and a half times longer than dorsal plate; basal clasp segment very slightly emarginate at the very base, densely setose; terminal clasp segment slender, slightly curved and for other characters, as in figure 13, with one very heavily chitinised, strong tooth apically; style as in figure 12.

Genotype.—*Pipaldiplosis pipaldiplosis*, sp. nov.

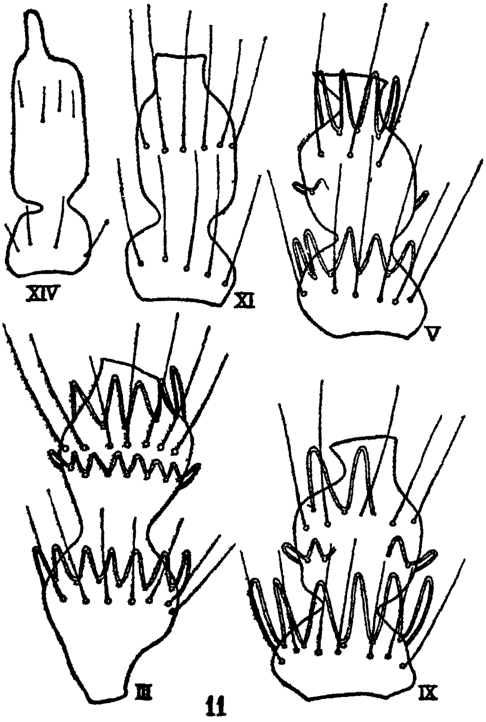


Fig 11.—*Pipaldiplosis pipaldiplosis*, sp. nov flagellate antennal segments, third, fifth, ninth, eleventh and fourteenth of male.

Pipaldiplosis pipaldiplosis, sp. nov.

Male.—2.5 mm. long. Dark reddish-brown. Mesonotum brown, scutellum lighter. Palpi: first segment very short, subglobose, stout; second segment twice the length of first, more slender, broadest at apical third; third segment very slightly longer than second, much more slender, somewhat clavate. Third, fifth, ninth, eleventh and fourteenth antennal segments as in figure 11. Claw curved subapically, almost as long as the empodium; pulvilli about half the length of claw. Apex of lobes of ventral plate broadly rounded, ciliate.

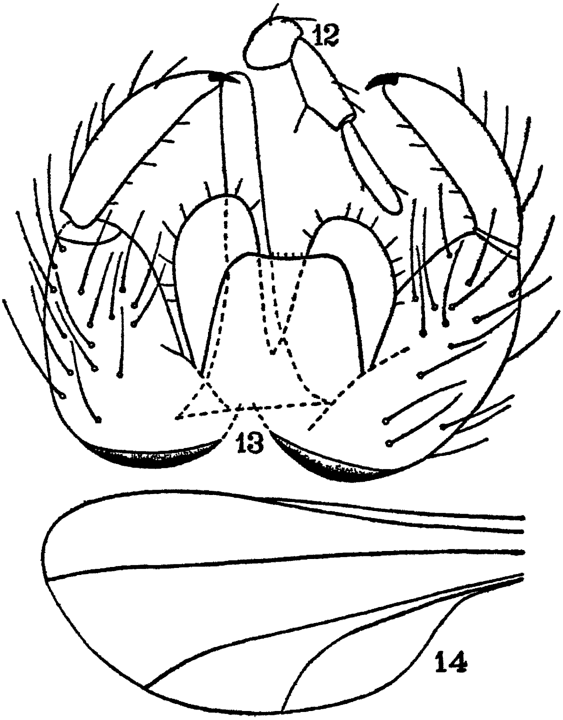
Female.—Not bred.

Holotype one male on a slide. Bred from the leaf-vein galls on *Ficus religiosa* Linn., at Delhi, M. S. Mani, 21. iii. 1942.

Galls.—The galls produced by this species were recorded by the writer in 1935 (*op. cit.*, p. 454). The galls were first collected in 1931 at Tanjore and later on at Calcutta, but the midges could not then be bred.

The galls measure (Fig 15) 10-50 mm. long and 5 mm. thick. Regular, ovoid, fusiform, local or extensive, tuberous, often unilateral and cortical, general, simple or branched, swellings of mid-rib, lateral veins, etc , of leaf, more prominent on the under side than on upper side, greenish-yellow when young and brown when old, often fissured and cracked; solid and ligneous.

Biology.—There appear to be at least four generations in the year, two generations being completed in early spring before the tree sheds the leaves for the hot weather and two more generations are completed about October. The eggs are laid singly on the under side of leaves near about the larger veins and the maggots on hatching bore into the veins, giving rise to the galls. The pupal period extends to about 6 days in spring. The total life-cycle occupies about a fortnight.



Figs 12-14.—*Pipaldiplosis pipaldiplosis*, sp. nov.
12. Palpus; 13 Male genitalia; 14 Wing.

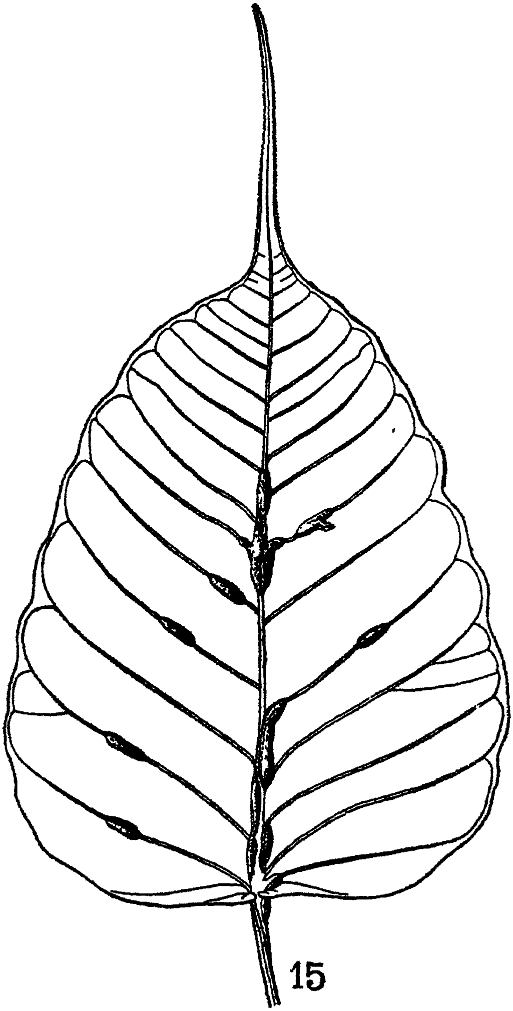
Distribution.—South India, Bengal, Delhi, Mewar and Dehra Dun; possibly all over India.

SPECIES *Incertae Sedis*.

A new shoot gall on *Pyrus malus*. An unknown gall-midge lays eggs in little clusters on the tender shoot of apple about March-April. The larvae hatching from them bore into the cortical tissues of the branches and give rise to irregular, globose, ligneous, hard, solid, tuberculate, local, lateral, often agglomorated and extensive swellings about 15-25 mm. in diameter, dark brown to dark grey in colour and of the characteristic appearance shown in figure 16. Numerous elongate-oval larval cavities are found in the solid woody substance of the gall. Over a dozen gall frequently occur on one foot of the branch.

Collected from Mussoorie foot hills, Dehra Dun (U. P.), M. S. Mani, 9 iii. 1941; and also from Ramgarh 6000 ft. (U. P.), H. S. Pruthi, 27.vi 1939.

No midge gall has so far been described collected from apple in India.



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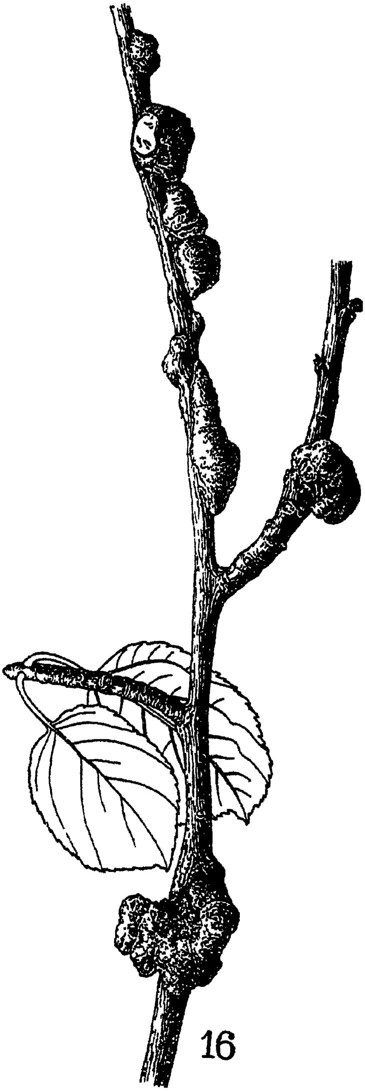

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Fig. 15.—*Pipaldiplosis pipaldiplosis*, sp. nov. gall on leaf vein of *Ficus religiosa* Linn.
Fig. 16.—Solid histioid shoot gall of *Pyrus malus* Linn.

BIONOMICS OF SOME COCCINELLIDAE, PREDACEOUS ON APHIDS AND COCCIDS IN NORTH INDIA

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I.—Introduction

The Coccinellidae are well-known to be of great economic importance because the majority of them are predaceous on injurious Aphids, Coccids, mites, etc Members of a relatively small sub-family Epilachninae are, however, herbivorous and occur as serious pests of brinjals and cucurbits in India. The predaceous Coccinellids have been successfully employed in the biological control of some injurious insects and the first spectacular success in this method of control was achieved in 1889 in California by employing the Coccinellid, *Rodalia cardinalis* (Muls.) for combating the fluted-scale, *Icerya purchasi* Mask. In 1929 this notorious scale insect was also discovered in India in the Nilgiri Hills where *Rodalia cardinalis* imported from California combated the pest with some substantial success. (Ayyar, 1940). *Cryptolaemus montrouzierei* Muls. is another very small Coccinellid which has also been highly successful in controlling *Pseudococcus citri* (Risso), a serious pest of citrus in California and elsewhere. Ayyar (1925) in the course of his studies on the Indian Coccidae discovered the very important part played by these beetles in controlling scale insects and recommended that "a thorough study of the bionomics of such Coccinellidae inhabiting any tract will prove of great benefit to economic entomologists who are anxious to try biological methods of control"

Very little attention has, however, been paid to this group by workers in India. Although over 300 species are known from this country, stray notes on the bionomics and life-histories of a few species only are available; these are by Lefroy (1909) on *Coccinella septempunctata* (L.), *Chilomenes sexmaculata* (Fabr.), *Scymnus xerampelinus* Muls. and *Brumus suturalis* (Fabr.); by Fletcher (1916 and 1919) on *Thea cincta* Fabr., *Sumnius renardi* Ws. and *Brumus suturalis*; and by Ayyar (1925) on *Scymnus andrewesi* ab. *coccivora* Ramkr.

At the suggestion of Dr. H. S. Pruthi, Imperial Entomologist. I undertook the study of the bionomics of *Adonia variegata* (Goeze), *Brumus suturalis* (Fabr.) and *Scymnus quadrillum* Motsch., which are common in Delhi and the Punjab. In the course of rearing these Coccinellids I found several important Chalcidoid parasites, brief notes on which are also given. I have followed Gage (1920) for terms used to describe the armature of the bodywall of the grubs.

This work was carried out while undergoing post-graduate course in the Entomological Section, Imperial Agricultural Research Institute, New Delhi, and I take this opportunity of expressing my grateful thanks to Dr. H. S. Pruthi, for his guidance and for providing facilities for work; to Dr. Taskhir Ahmad for his valuable help and kind supervision; to Mr. M. S. Mani for the identification of some parasites and to Mr. P. Narayanan who made sketches with his usual skill under my supervision.

II—**Adonia variegata** (Göeze), Tribe **Hippodamiini**

DISTRIBUTION, SEASONAL OCCURRENCE AND HOSTS

This palaearctic species is also recorded from China, India and Africa. Its first record from India appears to be that by Mulsant (1850), who described it as *Adonia doubledayi*, which is now recognised as a subspecies of *A. variegata*. The colour pattern in this species is very variable, with the result that it has been described under several different names and there are also about a hundred recognised aberrations. As far as the Indian record is concerned, Stebbing's (1914) account of *Hippodamia variegata* Göze var. *doubledayi* Muls. and *H. constellata* (Laich.) (not Crotch as mentioned by Stebbing) refers to this species. In India the species has been recorded from the northern parts only, *viz.*, Siwaliks, Kashmir, the Punjab, Dehra Dun, Mussoorie, Delhi, Fort Sandeman (Baluchistan), etc.

Adonia variegata is found in the Punjab and Delhi from about March to October. It is mainly an aphidivorous form and its occurrence thus depends to a large extent upon the presence of aphids. It is more common in Lahore than in Delhi. In Kashmir it is well distributed and has been found at places varying in altitude from 4500 to 9000 ft. during the summer months.

In the month of March the adults appear in the field in Delhi and feed on aphids. The beetles breed freely and increase within a short time and continue to be common up to July. They become active again in autumn in Delhi. In Lahore also in the month of October (1936), grubs, pupae and adults of this species were collected from colonies of the aphid, *Brachyunguis hermala* Das, infesting harmal (*Peganum harmala*).

Adonia variegata has been observed by the writer to feed on the following species of aphids:—

1. *Myzus persicae* (Sulze) on radish, peach, rape, mustard, cabbage, cauliflower and turnip, in Lahore and Delhi.

2. *Aphis malvae* (Koch) on cotton, hollyhock and several cucurbitaceous crops, in Lahore and Delhi.
3. *Brachycaudus pruni* (Koch) on peach, in Lahore.
4. *Brachycaudus hermala* Das, on harmal, in Lahore.
5. *Hyalopterus atriplicis* (Linn.) on *Chenopodium alba*, in Delhi.
6. *Eriosoma lanigerum* (Hausm.) on apple, at Srinagar, (Kashmir).

Stebbing records its hosts as the 'aphis of the peach tree', 'the blue pine aphis' or 'the spruce and silver-fir' (*Chermes himalayensis*). Outside India the following species are known to be preyed upon by this lady-bird: In Russia on *Aphis brassicae* (L.), *A. laburni* Kalt., *A. gossypii* Glov., *A. flava* Nevs., *Toxoptera graminum* (Rond.); in France and America on *Macrosiphum leptadeninae;* in Britain and E. Africa on *Eriosoma lanigerum* and in Italy on *E. inopinatum.*

LIFE-HISTORY

General observations on the behaviour of different stages in the life-history of *Adonia variegata* were carried out in the fields of the Imperial Agricultural Research Institute, New Delhi, as well as in the insectary, where the species was also studied at two constant temperatures, *viz.*, 25°C and 32°C.

Copulation and oviposition.—The precopulation period in the laboratory in March and April (avg. mean temp. = 29.6°C.) was three and the preoviposition period six days. Mating took place at different intervals during the day and if food was abundant the beetles continued to copulate and oviposit throughout their life. Fertile eggs were laid for about a fortnight after copulation; later on only infertile eggs were laid. Another mating, however, restored the fertility of the eggs.

Eggs (Pl. I, fig. 1) were laid vertically in batches consisting usually of sixteen to twenty-four eggs but sometimes the number per batch was as low as four and as high as forty-two. The eggs were laid generally on the under-surface of leaves and twigs both in the field and in the laboratory.

Table I below gives the oviposition figures based on average of eight pairs in each case under laboratory conditions and at 32°C. and 25°C. constant temperatures.

TABLE I.

Showing the fecundity of Adonia variegata *at different temperatures.*

Laboratory mean temp. 29·6°C			32°C			25°C		
Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
610	307	440	279	271	274	304	234	269

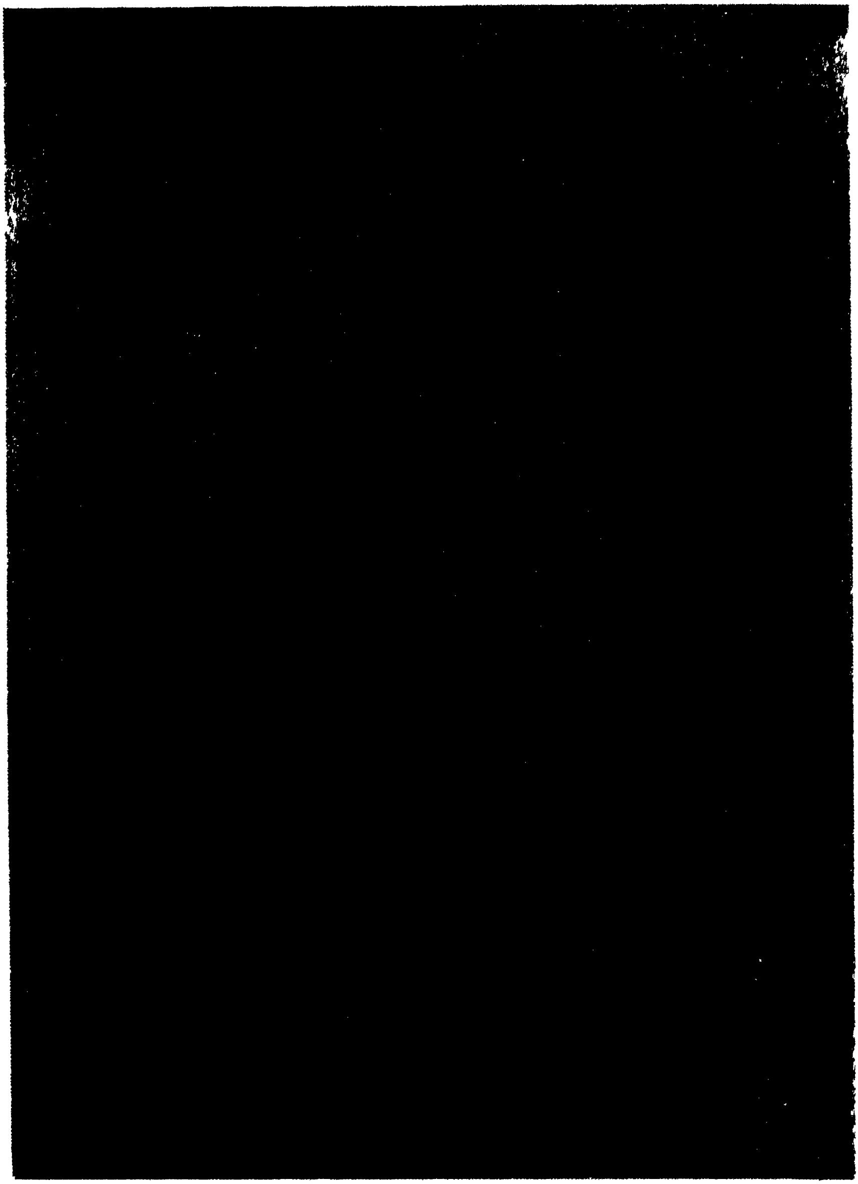

PLATE 1—*Adonia variegata* (Göze)

FIG.—1 Egg cluster (x 6); 2. Egg (x 20); 3. Newly hatched grub (x 20). 4. IV instar grub (x 14); 5 Pupa (x 14), 6. Adult beetle (x 12)

The Egg.—The egg (fig. 2) is cigar-shaped, 1.00 mm. long, and 0.35 mm. broad; yellow, with smooth and shiny surface.

At the time of hatching the chorion of the egg cracks irregularly in the subapical region and the young grub wriggles out. The incubation period was 2.0, 1.5 and 2.2 days for laboratory temperature (mean) 29.6°C., 32°C. and 25°C. constant temperatures respectively (based on average of over 100 eggs in each case).

The Grub.—Newly hatched grub (fig. 3) is 1.5 mm. long, 0.43 mm. broad across the metathoracic segment, sub-depressed, fusiform and widest at the metathorax; it is green in colour with the head darker. Stem of epicranial suture absent, it being represented only by the arms which diverge immediately from occipital foramen. Three dark coloured ocelli situated in a triangle on each lateral aspect of the head and a little above the antennal fossae; antennae three jointed, less than twice as long as wide; antacoriae protuberant and easily mistaken for the first segment; scape cylindrical and wider than long; pedicel less wide; flagellum borne at its subapical region and has tactile setae and sensoria at its tip. Dorsal shield of the prothorax large and covers the greater part of dorsum. It is lightly chitinized and bears several large chalazae fig. 3 (a) and many small setae. In the meso-and metathorax the dorsal shield is present as a raised oval area and bears several setae. The legs are relatively long; coxal fossae being slightly oval, the coxae are attached by membrane; procoxa bears a few scattered but prominent setae; protrochanter is short and triangular and bears coarse setae; profemur is fairly setaceous on its dorsal, caudal and cephalic surfaces; protibia is also setaceous and its distal region bears club shaped setae called the "tenent hair". The latter secrete some mucilage and aid the larva in having a firm hold on the substratum over which it walks. Protarsus is obsolete. Eight pairs of abdominal spiracles on segments one to eight are located on the cephalic margin of each tergum between the dorsolateral and lateral chalazae. Repugnatorial pores are situated on each lateral margin of the tergum in the coria between the segments one to eight. The armature of the abdominal segments consists only of chalazae and setae. The average duration of 1st. instar based on 25-15-25 grubs at laboratory, (avg. mean) 29.6°C., 32°C. and 25°C. temperatures was 2.0, 1.0 and 2.1 days respectively (table II).

The freshly moulted second instar grub is 2.5 mm. long and 1.8 mm. broad across the metathoracic segment. Its colour changes to yellowish-grey, excepting the head and legs which turn black; sometimes the ground colour of the body gives a frosted appearance. The thoracic tergites each bear a pair of sclerotized areas with sensory setae at their margins. The first abdominal segment also develops a pair of pale yellow areas on the dorsal side. The duration (based on average of 25-15-25 grubs) of the second instar at laboratory (mean) 29.6°C.-34.6°C. and 32°C. temperatures was one day each while at 25°C. it remained 2.1 days (table II).

In the third instar the grub measures 3.5 mm. in length and 1.2 mm. in breadth when freshly moulted. Its body colour changes to stone-grey while the head and legs remain black in the 2nd instar. The pale areas on the first abdominal segment noted in the second instar also assume light orange colour. The grub in this instar is very active and its duration was almost equal to that of the second instar as given in table II.

The freshly emerged fourth instar (fig. 4) is 6.2 mm. long and 1.8 mm. broad across the metathoracic segment. Its body colour remains the same as in the previous instar except that the posterior and lateral parts of the prothoracic tergites and the front of the head assume light orange colour. The abdominal segments first and fourth to seventh also develop light orange colour between the dorsal and dorsolateral group of setae on either side. In certain well-fed specimens the ground colour of the body gives a frosted appearance. The average duration of the fourth instar (based on 25-15-25 grubs) was 2.5, 2 3 and 3.1 days including about 8 to 16 hours of prepupal stage at the laboratory (avg. mean) 29-34·6°C. 32°C. and 25°C. temperatures respectively.

The pupa.—It (fig. 5) is 4.O mm. long and 2.5 mm. broad; brick-red in colour with variable number of symmetrically arranged black spots on body segments. Its abdominal segments were capable of movements and when disturbed it struck several times against the sub-stratum to which it was attached, and exuded the yellow fluid, as is done by the grub as well as adult beetle.

The duration of pupal period based on average of 30 pupae in each case at laboratory temperature (avg. mean) 29-34·6°C., 32°C. and 25°C. constant temperatures was 2.6, 2.4 and 3 2 days respectively.

The Adult.—Göeze while describing the adult of this species stated *nine* spots on elytra and not thirteen spots as subsequent writers, namely Mulsant (1846), Weise (1879), Ganglbauer (1899) and Reitter (1911), appear to have assumed. This fact was brought to light by Leman in .1921 and inspite of it the general conception of there being thirteen spots in *Adonia variegata* remains unaltered.

The adult (fig. 6) may be briefly redescribed as follows :—

Body elongate oval, 4.5 mm. long and 3.0 mm. broad; head not deeply inserted, yellow, with black transverse spot on the vertex, black spots frequently have a variable finger-like pair of markings in front; pronotum black excepting the white anterior-lateral margin and a pair of spots situated in the middle of the pronotum. The white spots in several cases extend and meet the anterior white margin but sometimes they are reduced and disappear in exceptional cases. The elytra are red to orange red, scutellum is whitish with a common black scutellar spot. In addition to which there are six black spots on each elytron. Numbering the spots from the base to the tip of elytron, the spot 1, 2 and 4 are in a line with linea externa; spot 3 and 5 lie on linea interna, the latter spot, however, extending transversely towards linea media. Spot 6 lies at the apical junction of linea interna and media. The size of the spots and their pattern is highly variable as a result of which about a hundred aberrations of this species are distinguished. Besides the variation in markings and pattern of the adults as pointed above, the general colouration of the grubs, pupae and beetles is subject to variation with changes in temperature during their development. Individuals reared at 32°C. constant temperature were of lighter colour than those reared at 25°C. constant temperature or those developed in the insectary or in the fields. Some stages were reared for this purpose at 13°C. & 16°C. and they developed a much darker shade than either of the categories mentioned above.

TABLE II.

Showing the duration in days of development of various stages of Adonia variegata *at laboratory and constant temperatures.*

Temperature °C	Preovi-position	Incuba-tion	1st instar	2nd instar	3rd instar	4th instar	Pupa	Adult beetle	
								Female	Male
Lab. mean temp. 29-34·6	5·1	2·0	2·0	1·0	1·0	2·5	2·6	34·0	28·0
32°C	3·0	1·5	1·0	1·0	1·1	2·3	2·4	16·7	15·2
25°C	4·5	2·2	2·1	2·1	2·4	3·1	3·2	25·0	21·0

The longevity of the adults based on average of 50 individuals in each case under insectary and 32°C and 25°C constant temperatures as shown in table II varied with different temperatures. It was also different for the two sexes. Under laboratory conditions whereas the average life of a female was six days more than that of male, at 32°C and 25°C constant temperatures this difference decreased to 1 5 and 4 days respectively. This is because the average longevity of the adults also decreases with the increased temperature. The post-oviposition period also decreased from 3 days under laboratory conditions to 1.5 days at 25°C temperature. At 32°C the females, however, continued laying eggs even to the last day of their life. Without food the young beetles lived from three to seven days, the average being four days under laboratory conditions Examination of over a hundred beetles collected from the field as well as reared in the laboratory revealed that the sex ratio was 3 males : 4 females.

FEEDING RECORD OF THE BEETLES AND GRUBS IN DIFFERENT INSTARS

The mode of feeding of the grub and adult is similar. The beetles grasp the aphids at any part but very often in the soft posterior region of the abdomen and nibble through the body-wall. The inner soft contents of the body are eaten bit by bit and the heavily chitinized parts such as the legs and wings etc., are left undevoured though in rare instance these parts are also eaten.

In experiments for testing the feeding capacity of a grub or an adult beetle, nymphs of *Myzus persicae* (Sulz.) were used as food without exception. Medium-sized nymphs were employed in order to check parthogenetic production of aphids in the cages (tubes). To know the normal percentage mortality of the aphids in the tubes control tubes were kept with aphids in them and this reading was taken into account while calculating the number of aphids consumed by the predators in the experimental tubes.

The number of aphids consumed by the adult beetles was very variable. Often the females consumed more than did the males and the number varied from 35 to 75 nymphs per day. When sexes were equally represented the average (based on 20 pairs) came to 45 nymphs a day. The total number of nymphs consumed by a single beetle during the life-time came to 1260 for male and 1530 for a female.

The observations for grubs are based on 20 individuals of each instar at laboratory temperature (avg. mean) 29·1°C and the results are presented below in table III.

TABLE III.

Showing larval feeding record of Adonia variegata *instar-wise*

1st instar			2nd instar			3rd instar			4th instar			Total larval period		
Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
21	8	14	37	13	21	38	20	30	79	46	56	160	98	130

Cannibalism.—The grubs and adults exhibited cannibalism in the rearing cages as well as in the field. It was observed that this practice was generally resorted to when there was shortage of food supply or when the cages were very much crowded. The adults were observed attacking the egg-hatches (generally fresh ones) and the pupae. The grubs fed on the weaker of their kin and also nibbled at the pupae. They were not observed attacking egg-masses.

These coccinellids depend mainly on Aphids for their food and it is well known that Aphids suffer from vicissitudes of weather, etc., and disappear suddenly. In such circumstances the cannibalistic habits of the grubs is advantageous in enabling some individuals to reach maturity and to fly away to more suitable places rather than let all the young ones to starve to death.

NUMBER OF GENERATIONS AND POSSIBILITIES OF MASS PRODUCTION

Table II shows a generation period (including the preimaginal and preoviposition periods) to be 16·2 days, 12·3 days, and 19·6 days for insectary temperature 29-34·6°C., 32°C. and 25°C. constant temperatures respectively. Taking into consideration the short generation period of the beetles and their appearance in the fields from March to July and again in autumn it is believed that six to eight generations are passed during a year in north India. Besides, with the short generation period and the large rate of egg-laying (avg. 440 eggs) under room-conditions, it is expected that the production of the beetles on mass scale would be possible under insectary conditions. The storage of adult beetles at 16°C and 13°C was tried for a large number of individuals and it was discovered that they could live without much activity, for over two months even if no aphids were provided in the cages.

PARASITES OF ADONIA VARIEGATA

Homalotylus flamineous (Dalman)—This Encyrtid is a well known parasite of coccinellids in India and abroad. It parasitised the grubs of last two instars and was first observed in the field in the end of April. It did not seem to reduce the population of the beetle to any large extent.

Parachrysocharis sp.—Only a few pupae of the beetle were parasitised by this species in April-May 1938. Several adults emerged out of one pupa.

III—**Brumus suturalis** (Fabr.), Tribe Chilocorini.

DISTRIBUTION, SEASONAL OCCURRENCE AND HOSTS

This species occurs all over India, Ceylon, Philippine and Lindi (East Africa). Lefroy (1909) reared this beetle from grubs predating upon *Phaenacoccus insolitus* on leaves of *Sida spinosa*. Fletcher (1919) reared it in February 1914, from a grub found in an egg-mass of *Pseudococcus* sp. on cotton. Very brief descriptions of the full-grown grub and pupa are given by these authors.

In India this beetle is reported to be fairly common throughout the year except during the extremes of climate. This is so probably because this predator has a variety of hosts, *viz.*, mites, Psyllids, Aleurodids, Aphids, Coccids, etc. This beetle is also reported to feed on the pollen of grasses (Gorham, 1894). The adult beetles have been previously recorded to feed on the following insects and mites: *Psylla isitis*, almost throughout India (Lefroy, 1913); *Trialeurodes ricini* in Madras (Subramaniam, 1923); *Phaenacoccus insolitus*, and *Pseudococcus* sp. in Bihar (Fletcher, 1919); *Pemphigus cynodonti* Das, *Brachycaudus pruni* (Koch); eggs of *Pyrilla* spp., *Dialeurodes citri* (Kuw.) and *Bemisia tabaci* (Gen.) in the Punjab (Das, 1918; Chopra, 1928; Hussain, 1929; Hussain & Trehan, 1933). The mites (*Tetranychus bioculatus*) fed are those found on jute and castor in Bihar (Misra, 1913).

The grubs were observed to feed only on soft bodied nymphs of certain aphids and mealy bugs by a peculiar mode of sucking and regurgitation as described hereafter. They were therefore, never so common in the field as the adult beetles themselves. At Delhi, in April-May 1938, the grubs were found predating upon the Aphid, *Hyalopterus atriplicis*, infesting '*bathu*' (*Chenopodium alba*) and in rare cases on *Myzus persicae* infesting several vegetable crops. Again, in August-October 1938, the grubs were common on *Pseudococcus* sp. infesting grass (*Cynodon dactylon*).

LIFE-HISTORY

Material for the study of life-history was collected in April-May from individuals feeding on *H. atriplicis* and were fed in the laboratory also on the same aphids. In August-October the individuals were collected from grass and fed on *Pseudococcus* sp.

Copulation and Pre-oviposition.—The beetles mated first after about three to four days and the average preoviposition period was 6·7 days (average of eight females) under the insectary conditions in April-June, (mean temp.) 33·7°C. and 8·4 days (average of 12 females) in August-October (average mean temp.) 30·6°C. On an average, based on ten pairs, a female laid 108 eggs when abundant food was provided in the cages. In the matter of laying eggs the beetles showed preference to plants infested with their food material. The eggs were laid in concealed places, between the curled and slightly dried up leaf edges and in grooves at the leaf bases and the branches. Unlike that in many coccinellids the eggs were laid slanting (fig. 7) one lying half over the other. They were laid in clusters containing 4 to 23 eggs.

The Egg.—It measures 1·0 mm. by 0·3 mm. (fig. 8). It is cigar-shaped and yellow in colour with numerous small and shallow depressions on the surface. The incubation period lasted 4·2 days in April-June and 5-6 days in August-October, 1938 (average based on over 70 eggs in each case).

The Grub.—The newly hatched grub (fig. 9), is slightly longer than the egg, is olive-green with darker head, thoracic shields and legs. In general structure it resembles a newly hatched grub of *Adonia variegata* described above, except that here the stem of the epicranial suture is present.

There are four instars; in April-June each occupied on an average 2·8, 2·1, 2·2 and 2·8 days in the sequence of their occurrence (average based on average of 15 individuals in each case). In August-October the duration was on the average 3·2, 2·7, 2·3 and 3·8 days respectively (average of 15 individuals in each case).

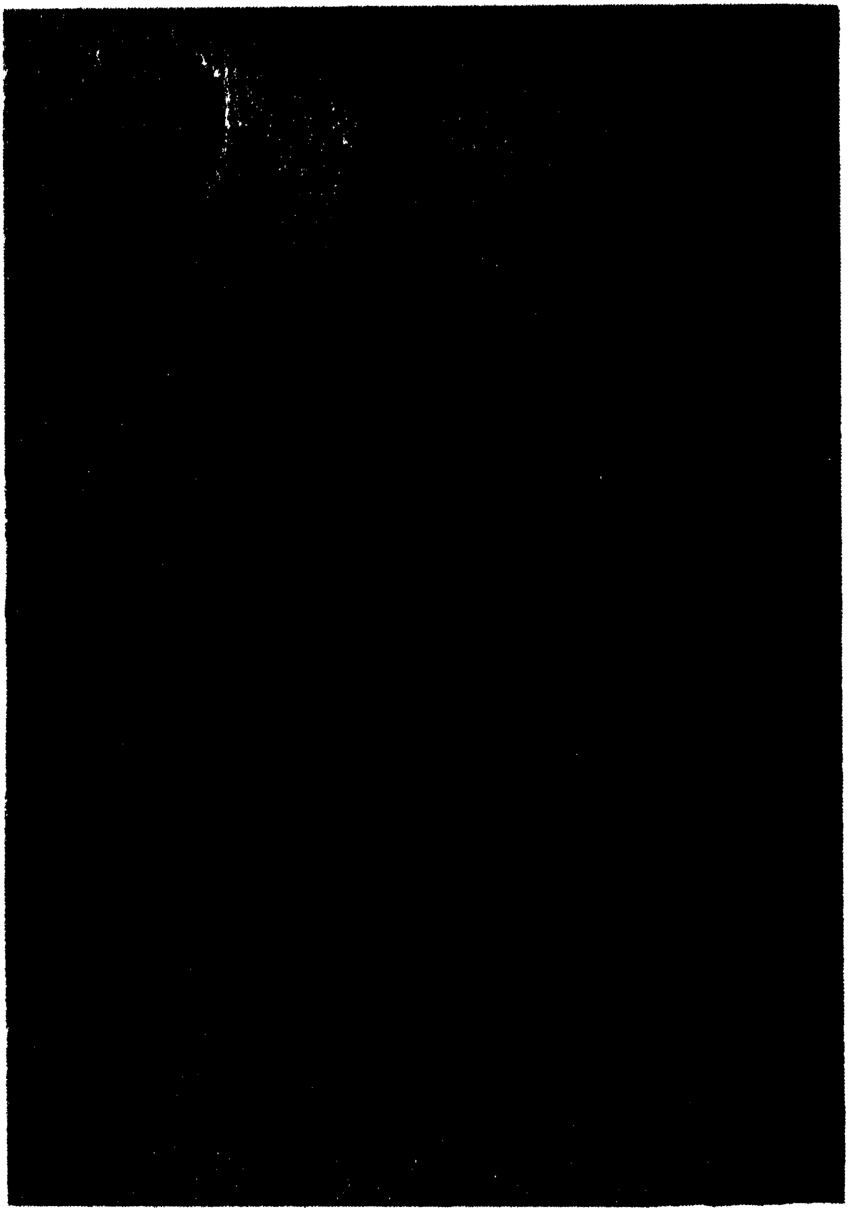

PLATE II.—*Brumus suturalis* (Fabr).

FIG.—7. Egg-cluster (x 10); 8. Egg (x 24); 9. Newly hatched grub (x 24); 10. Full-grown grub (x 10); 11. Pupa (x 10); 12. Adult beetle (x 12)

The full-grown grub (fig. 10) is 5·5 mm. long and 2·5 mm. broad across the first abdominal segment. It is broadly spindle-shaped and subdepressed. The epicranial suture extends forwards a short distance from the occipital foramen and bifurcates into two epicranial arms each of which extends latero-ventrally for a short distance and then makes a broad curve and extends ventro-medially towards the antennal fossae where it becomes obsolete. The front and post clypeus and labrum are included within the fork. Prothoracic tergum is light orange with a chitinized border bearing long chalazae and has a pair of plates each with a black rectangular spot (*b*) anteriorly. The meso and metathoracic terga each bear a transverse row of four parascoli (*psl.*), the two of each side being close together and indistinctly separated. They are dark grey in colour and well chitinized. The meso-and meta-pleural areas are well developed, each bearing a pair of brownish setae (*s*). The abdomen narrows gradually towards caudal end, its first and second segments are widest and subequal ; tergum of each segment one to eight bears four distinct setae arranged in a transverse row. Of these the dorsal two are black and the lateral two brown ; ninth abdominal segment is rectangular and devoid of setae groups but bears simple setae; tenth segment appears to be a ring of thin membrane surrounding the rosetted anal area and aids the grub in having a firm hold on the ground. Eight pairs of abdominal spiracles are situated on either side of abdominal segments one to eight. They are located near the cephalic margin of each tergum between the dorsal and dorso-lateral setae groups. Situated on each lateral margin of the tergum of abdominal segments one to eight is a repugnatorial pore through which a bad smelling fluid comes out. The writer did not observe on the grub of this species the "enormous waxy or white substance" as has been mentioned by Subramaniam (1923).

Mode of feeding of the grub.—The mode of feeding of the grub was remarkable. No previous worker has referred to such phenomenon in coccinellidae. It was observed to feed by a process of alternate sucking and regurgitation of the soft body contents of the prey. The process differs from that observed in the grubs of *Adonia, Chilomenes* and *Coccinella* and some other common coccinellids, which feed by a simple process of nibbling at the prey bit by bit, and devouring it ultimately except for the hard body-wall. A grub of *B. suturalis* on coming across the aphid or the mealybug attached itself firmly to the substratum by means of its rosetted last abdominal segment. The prey was held between the mandibles and pierced through. It was then held up in the air, by the grub raising its head and thorax; thus the prey had no hold on the ground. The body contents of the prey were sucked but it appeared that they were not passed down into the mesenteron as at the very next moment, they were regurgitated with great force back into the body of the prey resulting in dislodging its remaining body contents also. After repeating this process of alternate sucking and regurgitation four or five times the grub sucked in and passed the soft, fluid-like body contents of the prey into its own mesenteron. It repeated this process of alternate sucking and regurgitation several times till only the chitinous skin of the host was left behind. Ordinarily a grown up grub consumed from 10 to 15 aphids or mealy bugs in a day

The Pupa.—The pupation takes place in the open on a rough and dry surface of a twig or a leaf. In the field the grubs, when found in large numbers, often congregate for pupation Subramaniam's statement that pupation of *B. suturalis* takes place in concealed places under 'scales' etc. is quite contrary to what has been repeatedly observed by the writer. Subramaniam's account of both the grub and pupae seems to apply to the immature stages of some species of *Scymnus*. Before pupation the grub attaches itself by the tail and after a day the larval skin splits into two mid-dorsally the slit commencing from the prothorax and extending back to the sixth abdominal segment. The pupa (fig. 11) which is protected all round by the cast larval skin, is oval. It measures 3.2 mm. by 2.2 mm. and is pale-orange in colour.

The pupal period lasted for 4·5 days (average of 25 pupae) during the months of April-June, and for 6·7 days (average of 62 pupae) in August-October 1938.

The Beetle.—The beetle (fig. 12) was first described from India in 1798 by Fabricius under the genus *Coccinella* but in 1850 Mulsant placed it as a species of his newly formed genus *Brumus*. The beetle is oval, glabrous, 4.0 mm. long and 2·7 mm. broad across the middle of the elytra; the head is brown with a prominent pair of black eyes which, when the head is retracted, are slightly covered by the pronotum. The antennae are 9-jointed, brown and with small sensory hair all over. Each mandible has a basal tooth and a simple pointed apex. The pronotum is brown with a pair of notches in front of the eyes. The elytra are yellowish-brown except at their basal, lateral and apical margins There is a median longitudinal black stripe which extends from the scutellum to the apex of the elytra. Besides, there is a black stripe on outer side of each elytron starting from the humeral angle and ending before reaching the reddish area at the tip of the elytron. Legs brown with small hair all over and with a pair of simple claws at the terminal tarsal joint. The underside is brown or darkish brown, varying with age.

During April-June the beetles lived in the insectary from 30 to 45 days (average based on 18 individuals) while during August-December (average mean temp.) 22.2°C. the life was prolonged to 68 days (average of 42 beetles). They consumed from 16 to 30 nymphs of the aphid or mealy bug in a day, (average based on 12 beetles). The beetles and the grubs exhibited cannibalism rarely.

NUMBER OF GENERATIONS AND POSSIBILITIES OF MASSPRODUCTION

The average generation period (consisting of the preoviposition, incubation, larval and pupal periods) for the months of April-June came to 25.3 days, while during August-October 1938, it increased to 32.7 days in the insectary. The adults also lived from 30 to 68 days varying with temperature and are widelv distributed in India. Five to six generations are completed during the course of a year and the beetle are found commonly throughout the year except during the extremes of climate. Further comparative studies of the more favourable hosts of its grub are necessary to estimate how far this ladybird can be usefully employed in the biological control of insect pests. The present study, however, indicates that the beetles can be reared on a mass scale on *Pseudococcus* sp. infesting grass.

PARASITES

Homalotylus flaminius (Dalman) parasitized the grubs of this beetle in May and again in October 1938 but the parasitization remained very low.

IV.—**Scymnus quadrillum** Motsch., Tribe Scymniini

DISTRIBUTION, SEASONAL OCCURRENCE AND HOSTS

This species was originally described from Ceylon by Motschulsky in

1858 and of late it has also been recorded from Formosa (Korschefsky, 1932). The beetles have been commonly found by the writer in the Punjab and Delhi. There are also present some specimens of this species from Pusa (Bihar) in the collection of the Entomological Section of the Imperial Agricultural Research Institute.

In August 1938, there occurred a severe outbreak of *Aphis laburni* Kalt. on cowpea (*Vigna catjung*) and *mung* (*Phaseolus mungo*) in the experimental plots of the Entomological Section. The aphids were attacked by several predators which reduced the population of the pest within a short period of about a month and a half. The most common of these predators was *Scymnus quadrillum* which was present in all stages of its life-history. The less common predators were *Scymnus nubilus* Muls., the Syrphid *Paragus serratus* (Fabr.) and *Leucopis griseola* Fall. (Chamaemyidae). Special attention was paid to *Scymnus quadrillum* on account of the important role which it played in controlling the pest

The adults as well as the grubs are very active predators on aphids and scale insects. In Lahore and Delhi the writer observed the following species of aphids being consumed by the predator in the field: *Aphis laburni* Kalt., *A. gossypii* Glov., *A. maidis* Fitch., *A. nerii* Fons. and *Myzus persicae* (Sulz.). The adults were also observed to feed on *Aonidiella aurantii* (Maskell) and *A. orientalis* (Newstead) in Delhi.

LIFE-HISTORY.

Copulation and oviposition—The adults after emergence mated after four to six days in August-November (avg. mean temp.) 28°3°C. After another period of about five days the first batch of eggs was laid.

The eggs were laid, only on plants infested with *Aphis laburni*, in batches of two to eight but usually of four eggs. Occasionally they were laid singly also. The female exhibited a marked tendency to deposit her eggs in concealed places such as under the cast-off skin of aphids, in the partly rolled up leaves and in the crevices in the host plant. The female has a fairly long ovipositor for this purpose.

Usually one or two batches of eggs were laid in a day. The average (based on 15 pairs) per female in the insectary came to 43 eggs while the maximum number was 68 and the minimum only 18. During the later part of season October-November the fecundity was low. It was probably due to the scarcity of aphids and low temperature (avg. mean temp. 25·0°C).

The Egg—The egg (fig. 13) is oval, broader at the anterior than at the posterior end; 0·42 mm long and 0·21 broad, olive-green, matches the substratum over which it is laid and is smooth and shiny. In certain cases the colour is light olive but it is never yellow as is the case in most of the other coccinellids even though on some days adults were fed on green aphids. The incubation period varied according to the temperature from 4·7 to 6·3 days average based on 57 eggs (table IV).

The Grub.—The newly hatched grub is 0.52 mm. long and 0.22 mm. broad. Its body is amber coloured and the legs and head are yellow at first but later they become dark brown with a greenish tinge. The grub resembles in general a newly hatched grub of *A. variegata* described above except that its head bears a number of setae and the well marked epicranial suture. Its prothoracic segment bears four pairs of wax secretory pores. Each thoracic and abdominal segments, excepting the last one, bears three pairs of such pores namely, median, submedian and lateral pairs. About two hours after emergence the grub begins to secrete the wax but during this instar (fig. 14) the secretion is not enough to cover the larval body wholly. The average duration of the larval instars (as based on 20-10-12 grubs) is given in table IV.

The newly moulted second instar grub is 1.8 mm. long and 1.2 mm. broad. The body of the grub is brown and is completely covered with the white waxy tufts. The grub is very active and feeds on both small and large nymphs of aphids.

The third instar grub is similar to that of second instar and is 2.3 mm. long and 0.9 mm. broad when newly moulted. It secretes wax in large quantity, wax threads being thick and long with an indistinct bluish shade and frosty appearance.

The full-grown fourth instar grub (fig. 15) is 3.0 mm. by 1.6 mm.,.when measured without wax-threads; the head capsule is light brown, the epicranial sutures are obsolete and without epicranial arms. The sensory hairs are dark and fairly long; the ocelli are dark brown, two of them are equal in size but the third is almost twice as large as the other two together. The antennae are small, wider than long, only slightly chitinized and conical; the scape is about three times as wide as long; the pedicel is about twice as wide as long and its distal end is narrow; the flagellum is more or less mound like. The pronotum is not chitinized excepting the dorsal shield which is only weakly chitinized. It bears several dark setae arranged more or less in transverse rows. The dorsal shields of meso—and metathorax are also weakly chitinized and cover larger part of the dorsum and bear small verrucae on each side of meson. The abdomen is ten segmented, the last one being not visible from above; the first, second and third segments are widest and those behind the third become narrow gradually; the ninth segment is conical above, about half as wide as long and much narrower than the eighth; the tenth segment is like a rosette surrounding the anal area. There is one pair of thoracic and eight pairs of abdominal spiracles.

Mode of feeding.—The grub feeds on an aphid by a peculiar process of draining the fluid body contents of the host by puncturing it through one of its leg joints, cornicles or even antennae. A regular current of the body contents of the host passing through one of the knee joints, etc., into the mouth of the grub has been observed by the writer several times. The aphid makes all possible attemps to free itself but the grub never loses its hold. The grub firmly adheres itself to the surface below by its legs and the tip of abdomen. A grub consumes from eight to fourteen aphids or nymphs in a day as observed in six individuals.

The Pupa—The pupation takes place in the open on the leaves or branches of the plants. The pupa (fig. 16) is partially or sometimes wholly hidden beneath the waxy threads shed along with the moult of the full grown grub. It is oval and strongly convex; measures 2.0 mm. by 1.6 mm.; the colour is reddish-brown. Its anterior part is thickly beset with small hairs of a darker shade. The head, legs and distal portion of the wing-pads are hidden on the under side. Some-

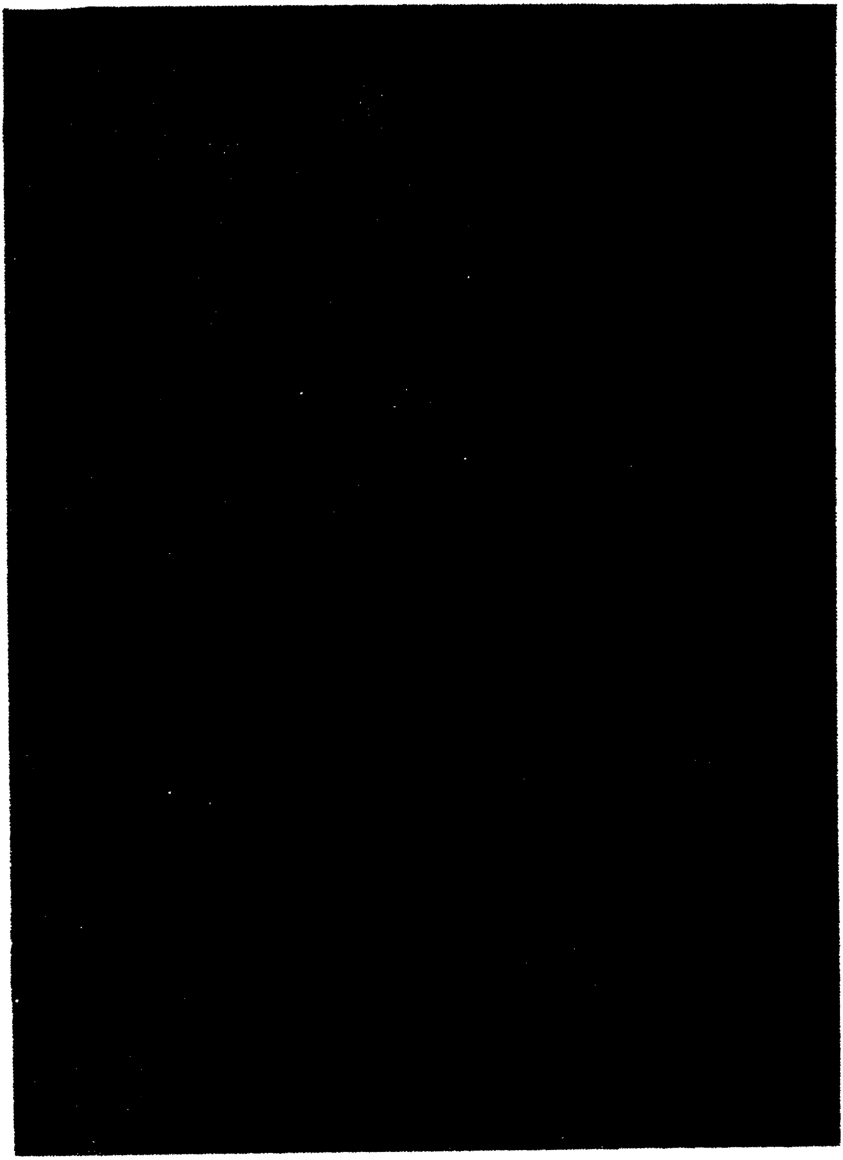

PLATE III —*Scymnus quadrillum* Mots.

FIG.—13. Egg-cluster (x 40); 14. 1st. instar grub (x 20); 15. Full-grown grub (x 20); 16. Pupa, etc. (x 20), 17. Adult beetle (x 20).

times the first four abdominal segments are also visible dorsally. The pupal period varied from 4·8 to 7·4 days according to temperature as given in table IV (averages based on 18 and 22 pupae respectively).

The Adult.—Immediately on emergence the beetle remains near the empty pupal skin. At first the colour of the beetle is golden-brown but after about 24 to 36 hours the characteristic violet colour of the prothorax and elytra is developed. The body is covered with fine pubescence and with advancement in age the beetle becomes shiny, as the pubescence is rubbed off slowly.

The adult beetle was first described by Motschulsky (1858) from Ceylon and in 1900, Weise briefly redescribed the beetle collected from Ceylon. A short description of beetle (fig. 17) may be given as follows:—

Body oval, 1·6 to 2·0 mm. long and 1·3 to 1·5 mm. broad across the elytra. The females are slightly bigger than the males. Dorsal side of the body as well as the eyes hairy. The head in the male is yellowish-brown while in the female the cranial region of the head is a little darker and the face yellowish-brown. The antennae are 11-jointed, short, brown and have sensory setae. The pronotum lies fixed at the base of the elytra. Its hind angles are bluntly pointed and its lateral margins are yellowish-brown; the middle part is violet and shiny. On each side of the elytra there are two reddish-yellow oblique spots, the anterior ones being larger than the posterior ones. Colour and size variation of spots is common. Legs brown, sparsely covered with fine setae, without tibial spurs, terminal tarsus bears a pair of sharply pointed claws.

The adults emerging in the insectary in the months of August-September lived for 25 to 50 days, the average life of 16 beetles being 34·2 days. The beetles that emerged late in the season (September, October and November) were comparatively long lived, some of them living over 78 days. The average of 12 beetles came to 45·6 days (table IV).

The adults and grubs did not exhibit cannibalism and from 12 to 18 nymphs of aphids were consumed by a beetle in a day.

TABLE IV

Showing the development of s Scymnus quadrillum *at laboratory temperatures.*

	Duration in days							
Month and avg. mean Temperature °C	Preovi-position	Incubation	1st instar	2nd instar	3rd instar	4th instar	Pupa	Adult beetle
August—September; 31·6°	9·5	4·7	2·7	1·3	1·3	1·3	4·8	34·2
October—November; 25·0°	11·6	6·3	4·3	2·2	2·2	2·5	7·4	45·6

NUMBER OF GENERATIONS AND HIBERNATION

The life-history studies show that there are three to four generations of the beetle in a year. During the period commencing from the middle of

August to the end of September, the total duration of immature stages of the beetle was on an average 16.1 days and the preoviposition period about 10 days.

Two generations were thus completed within this period. But during the later period, *i.e.*, from October to beginning of December the average duration of the immature stages was 24·9 days and the preoviposition period 11·6 days. Therefore, only one complete and a partial generation could be completed during the later period. Thus, on the whole, there were three generations in the year.

Before the end of December the beetles became inactive. The period of hibernation was passed in the adult stage during January and February after which the beetles resumed their activity and were found in the fields though not very commonly. As the rains set in and aphids appeared in large numbers in about the month of August, the activity of these beetles also increased and they started breeding in rich colonies of suitable species of aphids.

PARASITES

The following species of parasites of the grub of *Scymnus quadrillum* were reared in the insectary from the material collected from the fields at Delhi. Fortunately the parasites' attack appeared late in the season in October when the coccinellids had accomplished much of their useful task. The *Homalotylus* species were so active as to cause an appreciable decrease in the population of the Coccinellid grub and the maximum percentage parasitization was 42 in the last week of November.

1. *Homalotylus terminalis* (Say.) is recorded for the first time in India parasitizing grubs of *Scymnus quadrillum*. Previously the species was recorded only from U. S. A., on several coccinellids such as *Coleomegilla*, *Cycloneda* and *Anatis*.
2. *Homalotylus terminalis* subspecies *californicus* Girault. Besides the grubs of *Scymnus quadrillum*, some specimens were bred from grubs of *S. nubilus* Muls.
3. *Homalotylus* sp.* This species of *Homalotylus* was bred first in October 1938, from parasitized grubs of *Scymnus quadrillum*.
4. *Pachyneuron* sp.* *Pachyneuron* Walker is a plastic genus parasitizing a variety of hosts such as Aphids, Coccids, Psyllids, Coccinellids, Anthomyids, Syrphids and a number of other insects. Mani (1939) recorded this genus from India describing six species. The present species was bred from the grub of *S. quadrillum* on 22nd and 28th October 1940.

V—SUMMARY

The bionomics of *Adonia variegata* Goeze, *Brumus suturalis* (Fabr.) and *Scymnus quadrillum* Motsch. are given. *A. variegata* although a palaearctic species, is well distributed in North India and is found in the field from about March to October. It is an aphidivorous form and the feeding capacity of the adult and the grubs in various instars as determined by experiments indicates the species to be a useful predator. It has a short life-cycle which is completed in 16.2, 12.3 and 19.6 days in insectary (mean temp.) 29-34.6°C. and at 32°C and 25°C constant temperatures respectively. There

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*These species are probably new and are being described by me elsewhere.

appear to be from six to eight generations in a year and the possibilities of its mass production are discussed. *Homalotylus flaminious* (Dalman) parasitized the grubs of this species in the end of April.

B. suturalis occurs all over India and is found throughout the year except during the extremes of climate. It has a variety of hosts including Aphids, Coccids, Aleurodids Psyllids, mites and eggs of certain insects. Life-cycle in April-June and in August-October is completed in 25.3 and 32.7 days respectively. The grubs feed by a peculiar process of alternate sucking and regurgitation, a process which has not been recorded for coccinellids before. *H. flaminious* parasitized its grubs but the parasitization was low.

S. quadrillum, originally known from Ceylon and Formosa is recorded also from North India. Five species of aphids and two of coccids are mentioned as its hosts but the grubs have been observed to feed only on aphids by drawing their fluid body contents after puncturing through one of their (aphids) leg-joints, cornicles, etc. The life-cycle is completed in 26.1 days in August-September and in 34.5 days in October-November. There appear to be three generations in a year.

The grubs or pupae of this species are subject to attack of chalcidoid parasites in the month of October generally. The parasites recorded include three species of *Homalotylus*, and one of *Pachyneuron*. At the end of the season they reduced the population of the *coccinellid* by about half.

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ON THE BIOLOGY OF *EUZOPHERA PUNICELLA* MOORE IN BALUCHISTAN

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INTRODUCTION.

Euzophera punicella Moore (Pyralidae, Lepid.) is fairly common in Baluchistan. A brief account of the species was given by Pruthi (1938), but in view of its importance, the writer has made a detailed study of the biology of the insect during the last four years and the results are reported in this paper.

The writer feels indebted to Dr. H. S. Pruthi, Imperial Entomologist, New Delhi, for his criticism and valuable help in the presentation of the paper; to Mr. A. M. Mustafa, Director of Agriculture, Baluchistan, for his able guidance during the progress of the work; to the Imperial Institute of Entomology, London, for the identification of the species and to M. Sabir Janjua, Entomological Fieldman, Quetta, for his help in the field and laboratory.

DISTRIBUTION.

Euzophera is an extensive genus widely distributed in the Neotropical, Palaearctic and Ethopian regions. In India, several of its species are known to be stem or fruit borers. *Euzophera perticella* Rag. is a serious pest of brinjal and damages the stems of tomato and chillies, and potato tubers in several parts of India and Ceylon (see *Rep. 2nd and 3rd Ent. Meetings, Pusa*). *Euzophera plumbeifasciella* Hampson has been bred from *bael* and wood apple at Pusa and Coimbatore respectively. *Euzophera semifuneralis* Walker is known to bore into plum trunks in America (Hamilton, 1927) and *Euzophera bigella* Zeller is widely distributed in Europe, Central Asia and the Far East and has been found inside apple fruits along with the codling moth larvae and reported to be harmful to apple fruits in the same way as the latter pest (Gerasimov, 1930). *Euzophera punicella* was reared for the first time at Calcutta in 1890 from pomegranates sent by Cleghorn from Baluchistan (Cotes, 1891). Subsequently it was recorded from Baluchistan by Pruthi (1938) who described its mode of feeding and its status as a pest of apple. It is common in the districts of Quetta-Pishin, Zhob, Loralai and Sibi (Harnai Sub-Division). In Kalat State it is found in the districts of Sarawan and Jhalawan.

FOOD PLANTS AND FEEDING HABITS

In Baluchistan, *Euzophera punicella* is primarily a pest of pomegranates but it is also found in such specimens of apples, pears and quinces as are already damaged by the larvae of codling moth.

The first brood larvae of this Pyralid moth attack the young pomegranate fruit and tunnel inside either from the side or from the blossom end and feed on the flesh of the developing seeds. The infested fruit, when cut open, is found to be rotting, full of dark excreta and moulds growing therein, thus making the fruit unfit for human consumption. The growth of the infested fruit is checked and it presents an emaciated and stunted appearance. Scavengers and fungi invariably enter the fruit through the entrance holes made by the larvae and accelerate rotting.' Most of the pomegranate fruit, when half grown, crack along one side due to some physiological factors and the young larvae of subsequent generations being unable to bore through the tough skin of the developing fruit, usually enter through such cracks. The attack is more severe on the seedless *(Bedana)* variety than on the *Kandhari*, *Jalari* and *Mitha* varieties as the skin is tender in the former case and the larvae can, therefore, easily bore into the fruit. It has been estimated that about thirty per cent of the pomegranate fruit in the province is spoiled by this pest.

As already stated, the larvae of *Euzophera punicella* are almost invariably found in apples, pears and quinces already damaged by the codling moth larvae indicating that perhaps the *Euzophera* larvae are also primarily harmful to these fruits. A series of experiments were performed in which the *Euzophera* larvae were reared on healthy and infested apples, pears and quinces and as observed by Pruthi (1938) it was found that though the larvae were able to bore into sound fruit, they flourished best on the rotting and mouldy pulp due to the attack of codling moth larvae. *Euzophera punicella* is thus, not a primary pest, but generally damages those apples, pears and quinces which are already attacked by codling moth.

DESCRIPTION OF VARIOUS STAGES IN THE LIFE HISTORY

The Egg:—The eggs are laid singly but occasionally they are also seen in batches of two or three. They are deposited on leaves as well as fruit and are firmly attached to the surface by a sticky substance. The egg is oval, flat, disc shaped and creamy yellowish when freshly laid. The average length is 0·75 mm. and width 0·5 mm. The surface is rugose. In four or five days old eggs the progress of the development of the embryo can be seen through the thin egg-shell A few days before hatching, the mandibles and other mouth parts are evident; shortly afterwards, the head and thoracic shield are seen. The larva finally emerges through a circular cut at the anterior end.

The Larva:—Almost immediately after hatching, the tiny larva moves about and nibbles a little of the leaf tissue here and there. Eventually it reaches a young pomegranate fruit, bores into it and starts feeding on the flesh of the newly developing seeds. The entrance holes made by the larvae could be easily seen on the infested fruit. In apples, pears and quinces, the young larvae enter the fruit through the holes already made by the larvae of the codling moth and flourish best on the mouldy pulp.

The number of instars and the moulting activities of the larvae have been studied in detail. Six larval instars have been noted in the Quetta Valley and the description of the various instars is as follows:—

First instar·—Length soon after hatching 1·5 mm. to 1·8 mm. Head 0.2 mm. wide. General body colour grey; shape cylindrical, gradually tapering posteriorly Head pale brown; epicranium and frons light brown with the ocellar areas deep brown, sutures deep and prominent, adfrontal sutures indistinct. Mouth parts pale-brown, antennae and maxillae somewhat pale. Prothoracic shield sepia brown. Tubercles raised, unicolourous with the body. each bearing a short seta. Thoracic legs, anal plate and prolegs concolourous with the body. Each proleg bears 7 or 8 pale brown crotchets in uniordinal series. Spiracles indistinct. Body covered with numerous minute hairs arising singly.

Second instar:—Length soon after moulting 3·6 to 3·9 mm. Head 0·41 mm. wide. General body colour dark grey; head dark pale brown. Tubercles more distinct, prominent, unicolourous with the body, each furnished with a single seta. Thoracic legs.

anal plate and prolegs concolourous with the body. Each proleg bears thirteen or fourteen golden-brown crotchets in uniordinal series. Spiracles darker and more prominent.

Third instar:—Length soon after moulting 5·5 to 5.8 mm. Head 0·5 mm. wide. General body colour little deeper than in the previous instar. Head, epicranium and frons dark brown. Epicranial sutures somewhat black, adfrontal sutures indistinct. Prothoracic shield dark grey with a slight crimson tinge. Each proleg bears seventeen to ninteen crotchets in uniordinal series. Spiracles small, round, ringed with black.

Fourth instar:—Length soon after moulting 7·4 to 7·9 mm. Head 0·68 mm. wide. General body colour dark grey with pinkish tinge. Prothoracic shield dark grey with a definite crimson tinge. Tubercles conspicuous, shiny and unicolourous with the body. Each proleg bears twenty two to thirty crotchets in uniordinal series; hairs short, white, sparse; edges of spiracles raised, pimple-like, darker than general body colour. Head, prothoracic shield and anal plate bears silky hairs.

Fifth instar:—Length after moulting 9·1 to 9·7 mm. Head 0·75 mm. wide. Adfrontal sutures distinct. Tubercles tipped with black, each bearing a moderately long silky hair. Each proleg bears thirty to thirty six crotchets in an irregular biordinal series. Spiracles raised, circular with dark rim.

Sixth instar:—Length 13 to 15 mm. Width of the head capsule varying from 1·2 to 1·5 mm. General body colour dark grey with predominant pinkish tinge. Form subfusiform, shining. Head brown, retracted within the prothoracic segment. Antennae 4 jointed, 2nd longer than the remaining joints united, 4th very minute; two long acute papillae, one short hair and one very long bristle on distal edge of 2nd joint; 4th joint unarmed. Mandibles pentadentate, the three upper teeth pointed, the two lower blunt. Labrum with median incision, narrow, acute and has six setae; maxillae, lacinia galea with 4 long papillae, 2 laminate, bifid and 2 cylindrical with a minute distal joint, also 3 short processes between the bases of the papillae; third joint of maxillary palp with numerous short papillae. Prothoracic shield dark grey with a crimson tinge. Spiracles small, circular and pale brown with dark rims. Tubercles oval to egg shaped, slightly darker in colour than body, coarsely pitted. Prolegs with crotchets 40-46 triordinal arranged in an oval; anal proleg crotchets 24-30 triordinal, semioval; the crotchets of the third series are very minute, equal in number to and alternate with the long and the short crotchets. There are five pairs of prolegs including the anal claspers

When the larva is about to pupate, it constructs a thin, delicate, whitish cocoon generally inside the fruit. The cocoon is of fairly open texture so that the outline of the pupating larva or pupa within can be made out.

The Pupa:—Length 7·2 to 7·5 mm., breadth 1·75 mm. across the wing covers over the third abdominal segment. Shape elongate cylindrical, round at cephalic end, tapering at caudal end. General body colour brownish, the abdomen being a shade lighter than the body. Wings covers extend beyond the middle of the fourth abdominal segment where they are conjointly rounded in a broad arc. Spiracles of abdominal segments 2-7 uniform, elliptical, margins elevate; 8th linear with margins not elevate. On each of the abdominal segments there are two transverse rows of spines, a row of strong spines on the anterior margin and a row of weaker spines across the middle of each segment. Cremaster represented by 8 small rugosities at the apex of the 10th segment from which arises 8 cuphooked setae. The maxillary palpi are about twice as long as the labial palpi and completely enclose the latter.

The empty pupal shell remains within the cocoon when the moth emerges.

The Moth:—The moths fly at dusk only; at other times of the day they hide in crevices or dark recesses of the tree. Because of its colour, the moth is very inconspicuous and difficult to find, especially when resting on the bark or some other back ground. The male measures about 15 mm. across the expanded forewings. Hampson (1896) described the adult female as follows:—

> "Fuscous, suffused with black. Fore wing with diffused fuscous-black antemedial band with whitish band on its inner edge from cell to inner margin; a post-medial line excurved from costa to vein 2. Hind wing uniform fuscous. Exp. 20 mm.".

DURATION OF VARIOUS STAGES AND SEASONAL HISTORY

As a result of investigations carried out by the writer during the last four years it has been ascertained that there are four generations of the insect in a year in the Quetta Valley.

First Generation

During 1937, the first eggs were deposited on April 3, but oviposition continued up to May 2. The dates during 1938, 1939 and 1940 were April 4, March 29 and April 7 and oviposition continued up to May 5, April 28 and May 3 respectively. The incubation period of the eggs varied from 5 to 8 days with an average of 6.7 days; in 1938 from 5 to 7 days, in 1939 from 7 to 8 days while in 1940 it was from 6 to 7 days.

During 1937, eggs commenced hatching on April 10 and continued to do so up to May 7. In 1938, hatching started on April 9 and continued up till May 11; in 1939 they commenced hatching on April 4 and continued up till May 3, while in 1940 hatching was in progress from April 14 to May 9. The feeding period of larvae ranged from 25 to 31 days with an average of 28.7 days; in 1937 it was from 22 to 30 days, in 1939 from 20 to 29 days while in 1940 it was from 24 to 30 days.

At the end of the feeding period, the larvae start spinning cocoons which are usually found inside the fruit. The prepupation period, which begins from the time the larva stops feeding and ends with pupation, varied from 2 to 5 days with an average of 3.4 days. In 1937 it varied from 2 to 4 days; in 1938 from 3 to 5 days; in 1939 from 2 to 5 days while in 1941 from 3 to 4 days.

During 1937, the first pupation took place on May 5 and the last on June 2. The dates during 1938, 1939 and 1940 were May 8, May 4 and May 2 when first pupation was recorded and the last one was on June 1, June 5 and June 7 respectively. The pupal period varied from 5 to 8 days with an average of 6.9 days. In 1937, it varied from 6 to 8 days; in 1938 from 5 to 7 days; in 1939 from 6 to 7 days while in 1940 it was from 5 to 8 days.

In 1937, the first moths of the first brood emerged on May 11 and the last on June 7. The dates of first emergence during the three subsequent years were May 13, May 10 and May 7 and emergence continued up to June 9, June 12 and June 10 respectively. The length of the life of the adult fed on glucose syrup in laboratory varied from 3 to 8 days, the average being 6.3 days during May-June, 1939.

Copulation takes place soon after the adults emerge and lasts an hour to an hour and a half. Invariably it takes place at night. The preoviposition period varied from 2 to 4 days with an average of 3.3 days. The average time of egg deposition was 6.2 days varying from 4 to 8 days.

The egg laying activities of the moths were observed in detail. Oviposition usually occurs either early in the morning or just after sunset and as the time for oviposition approaches, there are indications of excitement on the part of of the female. After sometime she becomes quiet when the apex of her abdomen touches the surface on which she rests. She slowly lifts the tip of her abdomen and lays an egg. This process is repeated again and again until several eggs are laid in succession. The average number of eggs deposited by the first brood moths was 271.7—ten females depositing 2,717 eggs. The maximum number of eggs deposited by a single female was 478.

Life cycle of first generation:—The life cycle of the first generation varied from 32 to 52 days, with an average of 46·7 days. In 1937 it ranged from 36 to 50 days, in 1938 from 32 to 49 days, in 1939 from 35 to 50 days, while in 1940 it ranged from 38 to 52 days.

Second Generation

During 1937, the first eggs of this brood were deposited on May 14 and oviposition continued up to June 9. The dates during 1938, 1939 and 1940 were May 16, May 13 and May 10 and oviposition continued up to June 11, June 15 and June 13 respectively. The incubation period of the eggs varied from 4 to 7 with an average of 5·1 days. In 1937 it varied from 5 to 7 days, in 1938 from 6 to 7 days while in 1940 it was from 5 to 7 days.

During 1937, eggs commenced hatching on May 21 and continued up to June 14. In 1938 hatching started on May 23 and continued up to June 17; in 1939 they commenced hatching on May 19 and continued up till June 21, while in 1940 hatching was in progress from May 15 to June 18. The feeding period of the larvae ranged from 19 to 27 days with an average of 24·3 days; in 1937 it was 20 to 25 days, in 1938 from 19 to 26 days, in 1939 from 21 to 27 days, while in 1940 it was from 19 to 27 days.

The prepupation period varied from 2 to 4 days with an average of 2·8 days. In 1937 it was from 2 to 3 days, in 1938 from 2 to 4 days, in 1939 from 3 to 4 days while in 1940 it was from 2 to 4 days.

During 1937, the first pupation took place on June 19 and the last on July 8. The dates during 1938, 1939 and 1940 were June 13, June 9 and June 7 when first pupation was recorded and the last one in the three years was on July 12 and July 6 respectively. The pupal period varied from 4 to 7 days with an average of 5·2 days In 1937 it varied from 4 to 6 days, in 1938 from 5 to 7 days, in 1939 from 4 to 5 days while in 1940 it was from 4 to 7 days.

In 1937, the first moths of the second brood emerged on June 23 and the last on July 13. The dates of first emergence during the three subsequent years were June 18, June 13 and June 14 and emergence continued up to July 14, July 19 and July 10 respectively. The length of life of adult fed on glucose syrup in laboratory varied from 3 to 6 days with an average of 4·9 days during June-July, 1938.

The preoviposition period varied from 2 to 4 days with an average of 3·1 days. The average time of egg deposition was 5·8 days varying from 4 to 8 days. The average number of eggs deposited per female of the second brood was 243·2—ten females depositing 2,432 eggs. The maximum number of eggs deposited by a single female was 424.

Life cycle of second generation:—The life cycle of the second generation varied from 29 to 45 days with an average of 37·4 days. In 1937, it ranged from 31 to 41 days, in 1938 from 32 to 44 days, in 1939 from 30 to 42 days while in 1940 it ranged from 29 to 45 days.

Third Generation

During 1937, the first eggs of this brood were deposited on June 26 and oviposition continued up to July 15 The dates during 1938, 1939 and 1940 were June 21, June 17 and June 16 and oviposition continued up to July 17, July 22 and July 13 respectively. The incubation period of the eggs varied from 3 to 7 days with an average of 4·3 days. In 1937 it varied from 4 to 6 days, in 1938 from 3 to 5 days, in 1939 from 4 to 7 days while in 1940 it was from 3 to 7 days.

During 1937, eggs commenced hatching on June 30 and continued up to July 20. In 1938 hatching started on June 25 and continued up to July 18; in 1939 they commenced hatching on June 23 and continued up till July 25, while in 1940 hatching was in progress from June 20 to July 16. The feeding period of larvae ranged from 20 to 29 days with an average of 25·7 days; in 1937 it was 21 to 27 days, in 1938 from 22 to 29 days, in 1939 from 20 to 28 days while in 1940 it was from 23 to 29 days

The prepupation period varied from 3 to 5 days with an average of 3·2 days. In 1937 it was from 3 to 4 days, in 1938 from 4 to 5 days, in 1939 and 1940 it was from 3 to 5 days.

During 1937, the first pupation took place on July 26 and the last on August 20. The dates during 1938, 1939 and 1940 were July 21, July 17 and July 24 when first pupation was recorded and the last one in the three years was August 14, August 18 and August 21 respectively. The pupal period varied from 6 to 9 days with an average of 7·6 days. In 1937 it varied from 6 to 8 days, in 1938 from 7 to 9 days, in 1939 from 7 to 8 days while in 1940 it was from 6 to 9 days.

In 1937, the first moths of the third brood emerged on August 2 and the last on August 28. The dates of first emergence during the three subsequent years were July 29, July 26 and July 31 and emergence continued up to August 20, August 25 and August 23 respectively. The length of life of adult fed on glucose syrup in laboratory varied from 4 to 6 days with an average of 5·2 days during July-August, 1940.

The preoviposition period varied from 3 to 5 days with an average of 4·2 days The average time of egg deposition was 6·1 days varying from 5 to 8 days. The average number of eggs deposited per female of third brood was 293.9—ten females depositing 2939 eggs. The maximum number of eggs deposited by a single female was 491.

Life-cycle of third generation.—The life-cycle of the third generation varied from 32 to 50 days with an average of 40·8 days. In 1937, it ranged from 34 to 47 days, in 1938 from 37 to 48 days, in 1939 from 35 to 48 days while in 1940 it ranged from 32 to 50 days.

Fourth Generation

During 1937, the first eggs of the fourth generation were deposited on August 6, but oviposition continued up to September 1. The dates during 1938, 1939 and 1940 were August 1, July 29 and August 4 and oviposition continued up to August 26, August 29 and August 25 respectively. The incubation period of the eggs varied from 6 to 9 days with an average of 7.6 days. In

1937 it varied from 6 to 8 days, in 1938 from 7 to 9 days, in 1939 from 6 to 7 days while in 1940 it was from 6 to 9 days.

During 1937, eggs commenced hatching on August 15 and continued up till September 8; in 1938 hatching started on August 9 and continued up till September 4; in 1939 they commenced hatching on August 5 and continued up till September 2 while in 1940 hatching was in progress from August 12 to September 1. The feeding period of the larvae ranged from 22 to 31 days with an average of 26.7 days , in 1937 it was 23 to 30 days, in 1938 from 22 to 29 days, in 1939 from 24 to 31 days while in 1940 it was from 25 to 30 days. As the larva is full grown, it stops feeding and instead of forming cocoon inside the fruit, as in the case of first, second and third generations, leaves the fruit and seeks some suitable shelters under which it spins a cocoon. During 1937, the first larva came out from the fruit on September 12 and the last on October 2. The dates during 1938, 1939 and 1940 were September 7, September 2 and September 4 for the first larva coming out of the fruit and the last one on September 28, September 30 and September 25 respectively. On leaving the fruit, the larvae seek sheltered places and the loose bark and the burrows of Quetta Borer on pomegranate, quince and apple stems afford suitable places for cocooning. They are invariably found along with the cocoons of codling moth. The cocoons are formed of silken threads, more compact than those of the first three generations and are elongate in shape incorporating in their walls bits of bark, etc. Securely enclosed in these cocoons, the larvae pass the winter until the approach of the next spring season, when they change into pupae. The prepupation period including hibernation, which as in the case of first, second and third generations, commences from the time the larva leaves the fruit and ends with pupation, varied from 170 to 194 days with an average of 182·7 days. During 1937-38, it ranged from 174 to 183 days, in 1938-39 from 181 to 192 days, in 1939-40 from 170 to 187 days while in 1940-41 it was from 179 to 194 days.

During 1938, the earliest pupation of overwintering larvae occurred on March 14 and the last on April 7. The dates during 1939, 1940 and 1941 were March 10, March 16 and March 18 when first pupation was recorded and the last on April 7, April 10 and April 9 respectively. The pupal period varied from 15 to 21 days with an average of 17.9 days. In 1938, it varied from 16 to 19 days, in 1939 from 15 to 20 days, in 1940 from 17 to 21 days while in 1941 it was from 16 to 21 days.

In 1938, the first moths of the fourth generation emerged on March 28 and the last on April 25. The dates of first emergence during the three subsequent years were March 31, March 25 and April 2 and emergence continued up to May 1, April 23 and April 29 respectively. . The length of life of adult fed on glucose syrup in laboratory varied from 7 to 11 days, the average being 8·8 days during April-May, 1941. The preoviposition period varied from 2 to 7 days with an average of 4·7 days. The average time of oviposition was 10·6 days varying from 7 to 15 days. The average number of eggs deposited per female of fourth brood was 314.8—ten females depositing 3148 eggs. The maximum number of eggs deposited by a single female was 482.

Life-cycle of fourth generation:—The life-cycle of the fourth generation varied from 217 to 255 days with an average of 235·9 days. In 1937-38 it varied from 219 to 240 days, in 1938-39 from 225 to 250 days, in 1939-40 from 217 to 246 days while in 1940-41 it ranged from 226 to 255 days.

The life history data has been summarized in Table I.

TABLE I. *Summary of life history data of Euzophera punicella Moore.*

Stage in life history	1st Generation			2nd Generation			3rd Generation			4th Generation		
	Max. (days)	Min. (days)	Aver. (days)	Max. (days)	Min. (days)	Aver. (days)	Max. (days)	Min. (days)	Aver. (days)	Max. (days)	Min. (days)	Aver. (days)
Incubation period of eggs ...	8	5	6.7	7	4	5.1	7	3	4.3	9	6	7.6
Feeding period of larvae ...	31	20	28.7	27	19	24.3	29	20	25.7	31	22	26.7
Prepupal period (1st, 2nd and 3rd generations only) ...	5	2	3.4	4	2	2.8	5	3	3.2	—	—	—
Prepupal and hibernation period (4th generation) ...	—	—	—	—	—	—	—	—	—	194	170	182.7
Pupal period	8	5	6.9	7	4	5.2	9	6	7.6	21	15	17.9
Preoviposition period ...	4	2	3.3	4	2	3.1	5	3	4.2	7	2	4.7
Number of eggs deposited per female	478	137	271.7	424	163	243.2	491	152	293.9	482	266	314.8
Life cycle	52	32	46.7	45	29	37.4	50	32	40.8	255	217	235.9

(Average based on 25 individuals of each generation).

PARASITES

The larvae of *Euzophera punicella* have been found to be heavily parasitized by a Braconid wasp, *Apanteles* sp.

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STUDIES "ON DEAD-HEARTS" CAUSED BY DIFFERENT SPECIES OF SUGARCANE BORERS IN THE PUNJAB

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"Dead-heart" is a familiar term with economic entomologists. It is applied to the topmost sugarcane leaves which dry up due to borer activity in the plant. The number of leaves making up the "dead-heart" is variable and depends upon the species of the borer—this is true at least in the case of the more important sugarcane borers—responsible for causing it. This symptomatic significance of the "dead-heart" has not yet attracted attention of entomologists with the result that the term is applied very loosely and without any regard to its specificity. It is obviously of advantage to the entomologist to identify the culprit responsible for causing the "dead-heart" at a glance particularly when he has to survey whole fields of sugarcane to find the species of insect doing the damage and its prevalence. Besides, "symptomatology" of insect attack, as a whole, has not received its due share of attention at the hands of entomologists. Therefore, the objects of this communication are to (1) enable those interested in sugarcane Entomology to recognise the main sugarcane borers from the "dead-heart" produced by them and (2) stimulate interest in the symptomatology of insect attack.

Of the various sugarcane borers the following are the most important and destructive particularly in the Punjab :—

Scirpophaga nivella Fabr.
Argyria sticticraspis Hmpsn. and
Chilo trypetes Bisset.

Our observations were carried out at Jullundur on the "dead-heart" production by the first two, and that produced by the third at Mukerian, during May-July, 1940 and the popular variety of sugarcane, *viz.*, Co. 285 was selected for these observations.

The numbering of the leaves, as followed in this article, is shown diagrammatically in Fig. 1

The "dead-hearts" produced by important species of sugarcane borers are described below.

1.—Scirpophaga nivella Fabr.

The cane attacked by *Scirpophaga nivella* Fabr. (commonly called the top-borer of sugarcane) always shows a "dead-heart" (Stebbing, 1903) which consists of the dried up central fold of the leaves (Fletcher, 1919). As is now well-known, this caterpillar reaches the top of the cane by boring through the mid-rib. The newly hatched caterpillar always cuts a minute circular hole on the lower surface of the mid-rib of preferably the third or fourth leaf and

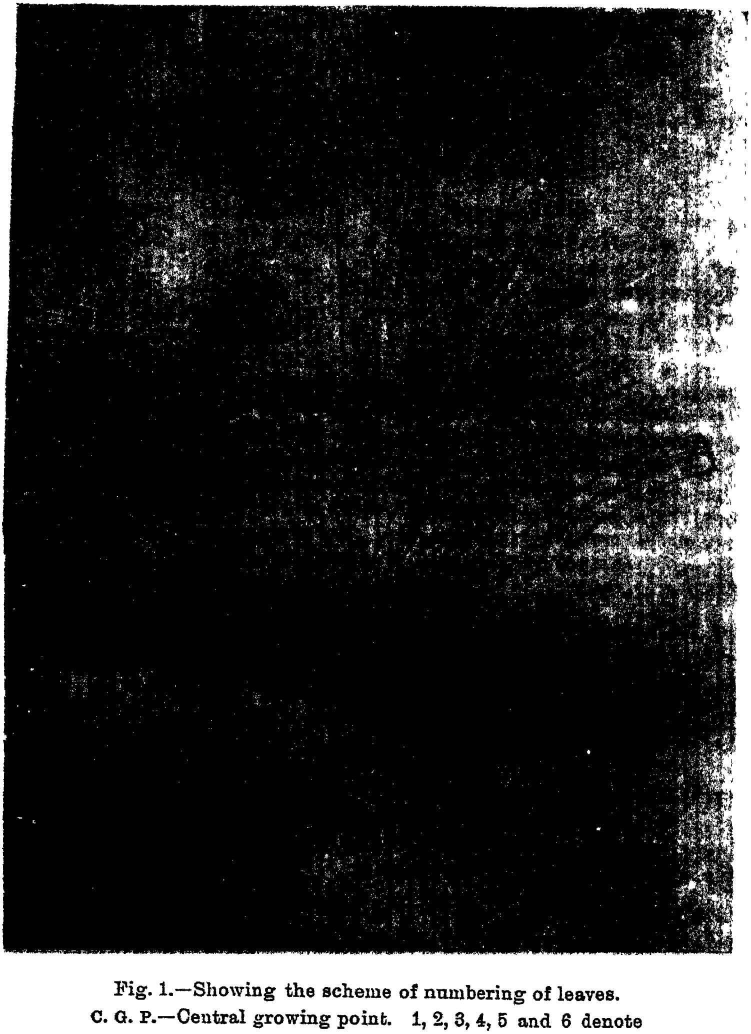

Fig. 1.—Showing the scheme of numbering of leaves. C. G. P.—Central growing point. 1, 2, 3, 4, 5 and 6 denote 1st, 2nd, 3rd, 4th, 5th and 6th leaves respectively.

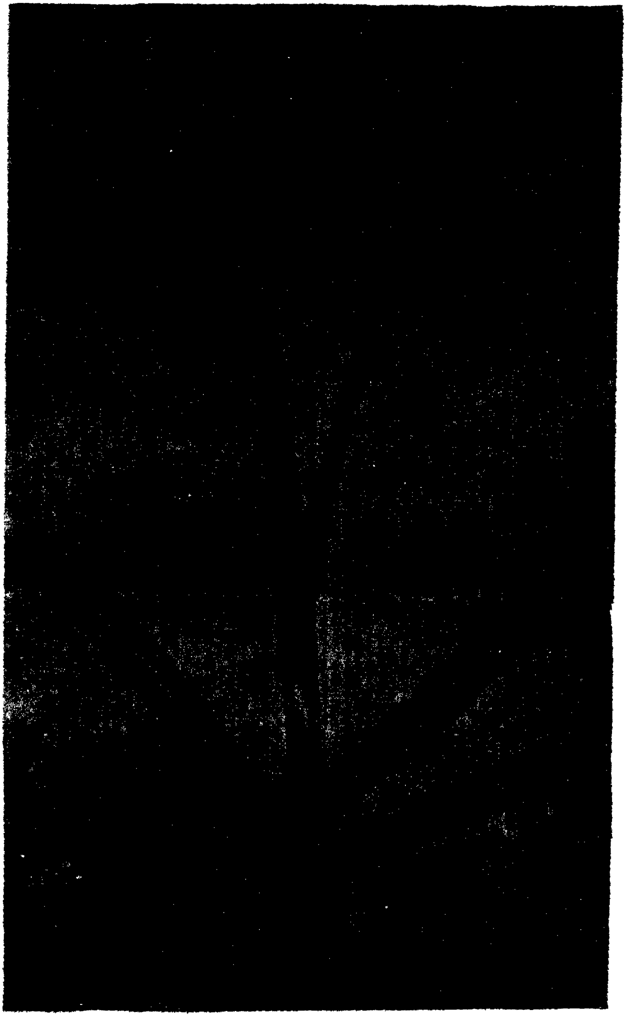

Fig. 2.—Showing dead-heart caused by *Scirpophaga nivella* F.
d. h.—dead-heart; d. i. m.—dried inner margin; b. c. h.—black circular holes; s. c.—side cuts; 3t—tunnel in the mid-rib of 3rd leaf.

tunnels through it: tunnels in the mid-ribs of the 2nd and the 5th leaves are also common and a few cases have been recorded where even the first and the 6th leaves were found affected. Once in the mid-rib, the caterpillar makes a longitudinal tunnel in it which is visible on its upper side (Fig.2, 3.t). 1-4 caterpillars may enter the same mid-rib but only one of them succeeds in entering the top of the cane. Each caterpillar makes a separate longitudinal tunnel of its own which extends parallel to one another and of these tunnels, only 56%-76% reach the base of the leaf. The mid-ribs of more than one leaf on the same plant may be utilized by different caterpillars for reaching the top of the cane: the number of tunnelled mid-ribs in 100 top-borer attacked canes was found to vary from 145-202 in different sugarcane varieties. The tunnel, through which the larvae successfully bore their way through the mid-rib (such tunnels are white to begin with but later on appear as reddish longitudinal streaks (Fig. 2. 3.t)) to the top of the cane, is, on an average, 14·0" long The caterpillar then eats its way through the tunnel which though having its inlet at the lower side of the mid-rib, runs nearer to the upper surface. If the bored leaf is old and separated from the central* whorl of leaves, the caterpillar reaches the base, and at the point of the junction, punctures the inner leaf which is tightly in contact and eats its way to the mid-rib through which it bores down for 1-5 inches. But if the outer leaf is still wrapped around the central whorl, the larva goes into the inner leaf at about the middle of the outerleaf where it touches the inner leaves. From there it enters the inner most whorl, tunnels down and causes a considerable damage to the central growing point which consequently dries up and causes "dead-heart" (Fig 2. d.h). The culprit, however, is not capable of totally disconnecting the central growing point from the lower part. Thus the "dead-heart" caused by *S. nivella* Fabr. is made up of only the** "leaf spindle" which on drying develops a reddish tinge but ultimately becomes deep dark red. It cannot be pulled out, but when tugged at with force, it breaks leaving no cavity behind. In addition, the first leaf either has a series of black side cuts (Fig.2. s.c) or—and this is commoner—dried up inner margin (Fig.2,d.i.m). Moreover, the first four leaves, and very rarely the 5th leaf, have small black circular holes (called shotholes) arranged in parallel rows across their width (Fig.2, b c.h). The number of the "shot-holes" varies from 3-61, with an average of 18, and the largest number of them are found on the first leaf.

2.—**Argyria sticticraspis** Hmpsn.

The first sign of the presence of this pest (commonly called the stem-borer of sugarcane) in a field, is the appearance of the "dead-heart" which consists of the dried up central shoot. The caterpillar enters from the side and eats its way into the interior of the shoot. This species is capable of completely severing the connection between the lower portion of the shoot and the central growing whorl of leaves. Our observations show that the "dead-heart" caused by *A. sticticraspis* Hmpsn. is made up of the "leaf spindle" and the first and the second leaves (Fig 3) and very rarely the third leaf; on an average, it is made up of 2.5—3 leaves. The "dead-heart" is greyish white in colour and, being completely severed from the parent plant, can be easily pulled out thereby leaving behind a well-defined cavity. The base of the "dead-heart", which gets completely rotted, gives an offensive smell.

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* Uppermost young leaves arranged in a circle round the axis.

** Central roll of unopened leaves

Fig 3 —Showing dead heart caused by *Argyria sticticraspis* H
Light shade—Dried leaves, *Dark shade*—Green leaves

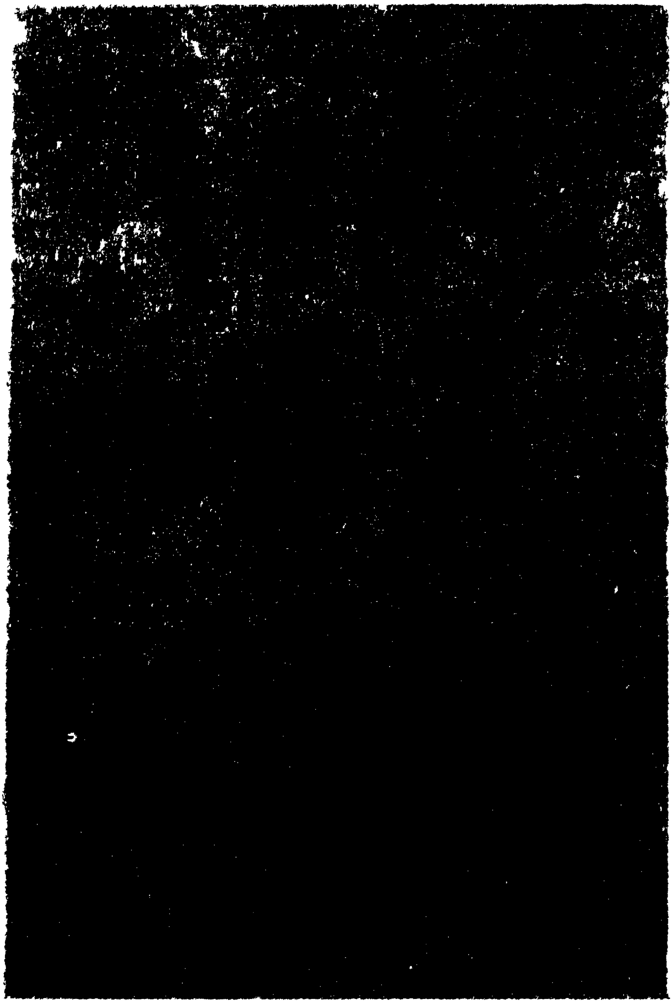

Fig. 4.—Showing dead-heart caused by *Chilo trypetes* Bisset
Light shade—Dried leaves., *Dark shade*—Green leaves.

3.—**Chilo trypetes** Bisset

This pest (commonly called the new pyralid borer) has been recently brought to light by Rahman and Tandon, (1940). According to them "in the beginning of the attack, side-leaves wither, but as the attack proceeds further, the entire whorl of the leaves including the "leaf spindle" dries up" (Fig. 4). The details concerning the number of leaves making up the "dead-heart" produced by this pest are given in table I below:—

TABLE I

Number of the leaf	Percentage of attacked canes wherein the leaf is found to be partially or completely dried up.
Leaf spindle	93.2
First	99.5
Second	99.5
Third	98.8
Fourth	23.1
Fifth	1.5
Sixth	0 6

It will be observed from this table that the "leaf spindle" in about 7 percent of the attacked canes remains healthy and that generally the 1st, 2nd and 3rd leaves dry up in the cane attacked by this pest. Thus, there is no "dead-heart", in the strict sense of the term, produced by this pest, because, it is the entire whorl of the top leaves of the attacked cane which dries up. The dried leaves are dull-white in colour.

4.—**Diatraea** sp.

The dead-heart caused by this species may, on superficial examination, be confused with that caused by *Argyria sticticraspis* Hamp. but the number of leaves which get dried up due to attack of *Diatraea* sp. is always more than three—on an average 4.5 leaves make up the "dead-heart" in this case. All the leaves in the whorl, except the outermost one or two, are affected and consequently get dried up. The "dead-heart" can be easily pulled out.

5.—**Emmalocera depressella** Swinhoe

The "dead-heart" caused by this species resembles the one caused by *Argyria sticticraspis* Hmps. in shape and colour but cannot be pulled out as the seat of damage is down below.

The symptomatology of the attack of different species of sugarcane borer is recapitulated below in table II.

TABLE II.

Diagnostic characters	Species of borers				
	Scirpophaga nivella Fabr.	*Argyria sticticraspis* Hmps.	*Chilo trypetes* Bisset.	*Diatraea* Sp.	*Emmalocera depressella* Sw.
1. No. of leaves making up the "dead-heart"	1-2	2 5	3 5	4.5	2.5
2. Description of damaged leaves ...	Leaf spindle, and first leaf	Leaf spindle first and second leaves	Leaf spindle and 1st to 6th leaves	Leaf spindle, 1st to 4th leaves	Leaf spindle, 1st and 2nd leaves
3. Can the "dead-heart" be easily pulled out?	No	Yes	No	Yes	No
4. Is a cavity left behind? ...	No	Yes	No	Yes	No
5. Colour of "dead-heart" ...	Dark red	Greyish-white	Dull white	Greyish-white	Greyish-white
6. Does the base of the "dead heart" smell?	No	Gives out offensive smell	No	Gives out offensive smell	No
7. Is mid-rib streaked?	Yes	No	No	No	No
8. Are "shot-holes" present? ...	Yes	No	No	No	No
9. Condition of the healthy leaves on the attacked plants	Conspicuously dark green	No difference from green leaves on healthy plants	No difference from green leaves on healthy plants	No difference from green leaves on healthy plants	No difference from green leaves on healthy plants

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SHORT NOTES AND EXHIBITS

Coccids attacking sugarcane in India

Ramachandran and Ayyar (2) listed only five species of Coccids as attacking sugarcane in India. Subsequently Ayyar (1) recorded *Aclerda japonica* var. *inermis* Green on this host. Observations made in various parts of India and the examination of the Impl Pusa collection of Coccids have brought to light a number of species hitherto unknown on sugarcane and some recorded for the first time from India. In the light of new knowledge obtained the following full list of coccids now known to attack sugarcane in India, has been prepared.

Diaspididae

1. *Lepidosaphes sacchari* Hall—This species has been found in United Provinces, Bihar, Bengal, and in N. India and Coimbatore in the South. This species which was not recorded hitherto from India was originally described from Egypt.

2. *Aonidiella glomerata* (Green)—This scale has been found in various parts of N. India and at Coimbatore. The attack is sometimes very severe.

3. *Duplachionaspis divergens* (Green)—This scale although noticed on *Andropogon nardus* and *A sorghum* in India, has not been known to attack sugarcane. This species has recently been found doing some damage at Coimbatore. The attacked plants, specially young wither away completely.

4. *Odonaspis secreta saccharicaulis* Zehntner—This species has been found attacking sugarcane only at Coimbatore. This is the first record of the species from India.

5. *Temnaspidiotus kellyi* (Brain)—This scale which was first described on a grass in South Africa, was noticed on sugarcane at Delhi. This is the first record of this insect in India.

Pseudococcidae

6. *Ripersia sacchari* Green—This species was first described by Green from specimens obtained from Gorakhpur. It has also been obtained from Bihar, Bengal, Poona and Coimbatore.

7. *Trionymus sacchari* (Cockerell)—This species has been recorded from Poona, Delhi, Karnal, Gorakhpur, Pusa and Coimbatore. This is a very widely distributed species.

8. *Pseudococcus saccharicola* Takahashi—This mealy-bug which was first described from Formosa has been found doing some damage at Coimbatore. It appears to have been recently introduced in India.

9. *Pseudococcus saccharifolii* Green—This mealy-bug has been found at Samalkot and Pusa. We have noticed this species at Delhi, Karnal and Meerut on sugarcane.

10. *Antonina indica* Green—This species has been found attacking sugarcane at New Delhi and Coimbatore. This was so far known only to attack grass.

Aclerdidae

11. *Aclerda japonica* Newstead—This has been recorded in various parts of the sugarcane growing tracts both in N. India and S. India.

12. *Aclerda distorta* (Green)—This species was obtained at Coimbatore. This is the first record from India.

13. *Aclerda japonica* var. *inermis* Green—This has been found by Ayyar (1) on leaf sheaths of sugarcane at Anakapalle in the Madras Presidency. We have not seen this species.

Margarodidae

14. *Icerya pilosa* var. *nardi* Green—This giant mealy-bug has been found at New Delhi, Karnal, Meerut and Coimbatore.

New Delhi, January, 1942. H S. PRUTHI and V. P. RAO

The Cotton-Stem-Weevil—A Friend or Foe ?

Pempherulus affinis (Faust), the cotton-stem-weevil is generally considered to be one of the major pests of cotton in India. The writer's observations on five varieties of cotton (*Wagale*, C19 x W5, L11 x W6, Rosea x (S x W) and (S x W) x Dh2) at the Cotton Experimental Farm, Mahlaing (Burma) during 1937-39 show on the contrary that an attack by this weevil does not in any way impair the productivity of the cotton plant, provided the attack does not occur before the plants are about two months old. If cotton is attacked before this time, most of the plants are killed off ; such early attack is very rare.

It was found in the above mentioned experiments that (*i*) the cross L11 x W6 which was the most heavily attacked yielded the highest of all the varieties ; and other varieties which were relatively less attacked yielded correspondingly less ; and (*ii*) in corresponding plots of the same variety of cotton those with a higher percentage of infested plants yielded more *kapas*. These results were found statistically sound also.

One explanation of this astounding fact may be that the intensity of infestation and the yield of *kapas* may be positively correlated to some other factor in the plants, such as succulence, but entirely independent of each other. This explanation, however, is untenable, because if the attack by the weevil were definitely harmful to the plant in reducing the yield of *kapas*, then the vigour, succulence or any other such factor on which depended the intensity of attack and the yield, would have to increase at an incredible rate in order not only to compensate for the loss due to the weevil but also to increase the yield as much again.

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The true explanation appears to the writer to be based on different reasons: Cutting off the supply of water by draining away the fields or adding phosphates to the soil, so that absorption of water and other nutrients by the root is checked, or by allowing cattle to trample the plants, is known to check unnecessary vegetative growth and to induce flowering and ear-formation in paddy plants. In the same way too luxurient vegetative growth leaves the cotton plant insufficient time and capacity for satisfactory flowering and fruiting. By tunnelling round the effective vascular system of the plant, the weevil grub cuts off the supply of water and nutrients, thereby inducing flowering and fruiting in time.

According to the writer's experience, the number of plants having at all suffered seriously due to even a heavy attack of the weevil has been very small indeed : probably the larval burrow is not moist enough for any fungi or bacteria to breed therein and do any harm. The stem is also not weakened to such an extent as to break under the stress of high wind, unless the infestation on individual plants is very heavy and the stem is very badly riddled with tunnels ; and these cases are extremely rare.

The writer, therefore, is of the opinion that the stem-weevil of cotton may in fact be a blessing in disguise ; though apparently a pest boring the stem, it is a desirable check on the superfluous vegetative growth of the plant and a timely "stimulus" for it to flower and fruit. Further experiments may decide whether *P. affinis* is really a pest or a friend of the cultivator and may further lead an entomologist to revise the status of many an insect called pest today.

New Delhi SHUMSHER SINGH

Note on *Empoasca punjabensis* Pr., the causal agent of hopperburn in potato.

During the last season, potato badly suffered from hopperburn at Delhi produced by *Empoasca punjabensis* Pr. Pruthi [*Indian J. Ent.*, **2**, (1) : 1-10-1940], originally recorded this Jassid on bajra, beans, brinjal, carrot, cotton, guava, lentil, lucerne, potato, safflower, tobacco, tomato and zinnia. This year (1941-42) it proved the major pest of potato at Delhi.

The jassid oviposits on leaf-veins. The nymph moults five times in about 19—21 days at the average maximum and minimum temperatures of 65°F. and 60°F. respectively ; and 17 days at 71°F. and 65°F. respectively. The adult lives for 7-15 days under the same conditions.

Both the nymphs and adults infest the lower surface of lower leaves, in between primary veins, seldom on stems or leaf-petioles. Being non-migratory, nymphs feed on the same leaf for a long time thus causing relatively more hopperburn than adults. There are roughly five stages in the formation of hopperburn comprising of etiolated spots and patches, burning (browning), and rotting of leaf-margins, leaf-tips and finally the death of leaf. It appears that the hopperburn is possibly caused by mechanical injury to plant cells, physiological disturbances created by desapping, toxicity of the jassid saliva and the slits made by emerging nymphs which bring about sudden collapse of leaf parts oviposited upon by the female. No specific virus appears to be involved though in certain stages, the potato hopperburn would apparently resemble the symptoms of potato leaf roll (in "Arran Comrade") and Leaf-drop-streak disease (in "President" variety).

In the field, the potato sprouts about one month old (*i.e*, in November), were visited by the adult jassid and the hopperburn was more or less inconspicuous till the end of December when the crop showed marked signs of hopperburn due to the delayed appearance of the nymph. The attack of this jassid in the field is confined usually to certain localities and also shows some varietal preference namely, varieties like "gola" and "italian white" suffered the most, whilst "phulwa" lightly escaped the hopperburn. Brinjal, lucerne, tobacco, tomato and safflower also suffer from hopperburn in varying degrees. Further investigations are being made.

New Delhi E. J. VEVAI

Trypanea stellata Fuessly, a new pest of some Compositae in India.

Trypanea stellata Fuessly, (Trypetidae: Diptera) is widely distributed in different parts of the world. In Europe the maggots of this fly feed in the flower heads of Compositae. The fly is being recorded in Delhi for the first time from India. In the Safdarjang Nursery, New Delhi during October, November and December 1941, about 25 to 30% of the flowers of *Calendula officinalis* were attacked by the maggots of this fly. The infested buds either do not open at all, or open partially, flower-heads get shrivelled due to rotting of the attacked florets. Sometimes the maggots bore into the thalamus in which case the flower-heads droop down and dry up. No seed formation takes place in the infested flowers.

The adult flies are lovers of sunshine and remain active throughout the day. The female deposits its eggs in clusters of 4 to 10 or even 20, either in the buds or in between the florets of the open flower heads. Pupation generally takes place in the flowers but sometimes in the soil as well. The duration of the various stages in the life-history from October to April can be summed up as follows:— egg 1 to 2 days, maggot 5 to 12 days, pupae 6 to 40 days and adult 8 to 22 days.

New Delhi, 12th June, 1942 KANWAL K. NIRULA

A note on the habits of *Eretis sticticus* L., a predator on mosquito larvae.

Eretis sticticus L. (Dytiscidae) has been known to feed on mosquito larvae (*Culex* sp. and *Anopheles* sp.) for a long time, but the habits of this beetle, which were not fully known, were studied in detail at Delhi.

With the onset of monsoon, the beetle is found in great numbers in stagnant waters. The cylindrical, whitish eggs are laid singly in mud at the bottom of water and are covered with a layer of foamy secretion. The incubation period is about 3 days in August.

The small newly hatched larva is very active; on being disturbed it darts into water shooting to the surface again. It is predacious on all stages of mosquito larvae. A full-grown larva feeds on as many as 100 larvae in 24 hours. About 350-400 mosquito larvae are eaten by a single individual during its development. It pounces on its prey and catches it at its hind end with its strong mandibles, drags it under water and eats it leaving only the head capsule. The predator larva is cannibalistic. The larval period is 8-12 days in August. The full-grown larva burrows into the soil on the sides of ponds to about three inches depth and forms an almond shaped smooth cavity and pupates therein. The pupal period is 4-6 days during August.

In the absence of food, the adult beetles are cannibalistic. They are very swift fliers and in rare cases are attracted to light.

New Delhi SHER KHAN

Antilochus cocqueberte (Fabr.) a predator of *Dysdercus cingulatus*

Early in November last, *Antilochus cocqueberte* (Fabr.) was observed predating on *Dysdercus cingulatus* (Fabr.) in cotton fields at Delhi and at Karnal. From what was observed there was no doubt that it was a case of well established predatism. The predator remained active throughout November but disappeared rather suddenly early in December.

It was quite interesting to observe the ferocity with which *Antilochus* attacked *Dysdercus*. The predator would actually run after the prey and practically jump on to it and pin it down, thrusting at once its proboscis into its antennal cavity. The prey would be apparently cowed at the approach of the predator and when caught hold of would hardly struggle for a few seconds before being completely paralysed by the predator's proboscis piercing deep into its head. The predator, after paralysing the prey, would continue sucking its body fluid at ease but with tenacity at times up to 30 minutes or so till the prey is completely drained off and looks quite empty against light. Sometimes the predator would take out its proboscis from the antenal cavity and begin sucking through the intersegmental membrane on some other part of the body. The tenacity with which *Antilochus* sucks will be evident from the fact that several times its was possible to chop off its proboscis while it remained deeply thrust into the body of the prey.

New Delhi S. PRADHAN and R. MENNON

Julodis atkinsoni Kerr

This Buprestid beetle was first reported from Dehra Ismail Khan (Punjab) causing considerable damage to cotton and melon crops in June 1895. (*Indian Mus. Notes*, **4** (2): 49 (1896).

A female of this beetle was recently found feeding on "*joasa*" leaves at Delhi. It also fed on leaves of cotton, hollyhock and *Zizyphus* in captivity and laid 38 eggs in the soil singly as well as in small batches in 32 days. The eggs are creamy-brown and cylindrical, with rounded ends. The incubation period is 35 days. The larva comes out by making an opening near the middle of the egg. The larvae on hatching go into soil where they feed first on the roots. This is the first time since 1895 that eggs and larvae have been obtained and the feeding habits of the larva observed.

New Delhi M. BOSE

Biological notes on two new egg-parasites of *Bagrada picta* Fabr Pentatomidae.

There is no previous record of any parasite of *Bagrada picta* in India. The writer recently discovered two new species of *Scelionids* (Serphoidea) parasitizing the eggs of this bug at Delhi in a field of cruciferous crops under rather interesting circumstances. Contrary to the prevailing view, *B. picta* lays eggs in the soil at a depth of about ¼". They are laid in irregular groups of 15 to 75 eggs in loose soils found near ant-hills, termite-nests, rat-burrows, etc. Total number of eggs laid per female during March-April was 55 to 228, the average being 155 Newly laid eggs are generally copiously covered with a mucilaginous secretion, and since the chorion is minutely fringed with short hairs, the soil particles readily adhere to their surface, forming a protective case to each egg in a cluster. Towards the first week of March, large numbers of adult parasites were observed emerging from the soil and closer examination revealed the first stage nymphs of *Bagrada* also emerging from the same place. The parasites and nymphs continued to emerge from the soil till the end of April. The parasites collected from the field freely oviposited and bred in the eggs of *B. picta* laid in the soil in the laboratory. One of the parasites has been found to be an underscribed species of the genus *Liophanurus* while the other which is relatively more abundant is possibly a new species of the genus *Tiphodytes.* The former was more abundant towards the end of April and the latter towards the end of May.

Liophanurus sp.—Parasitism by this species which was about 15% in the middle of March increased to 25% by the end of April when the pest was at its maximum intensity. The ratio of male parasites to females that emerged in the field was 1 : 3. In the laboratory, 30% of the host eggs laid exposed without the soil were parasitized by a single female against 20% of those laid in the soil. The soil covering around the eggs very probably affords certain amount of protection to them against parasitism. Newly laid eggs seem to be comparatively less preferred for parasitism than 24 hours old ones as the former are covered with mucilaginous secretion, and this preference for parasitism extends until the eggs are 4 days old. At first, the parasite is seen rapidly moving about on the egg-cluster tapping each egg by means of its antennae, and thereafter it inserts its ovipositor into the sutured margin of the operculum. The host-egg turns light grey 4 days after it has been parasitized and dark grey after another day or two. The parasite comes out of the egg by pushing the lid open much in the same way as the young nymph of the host. The egg-shell, after the emergence of the parasite, can be distinguished by the absence of the membranous exuvium (or post natal moult) which is usually seen protruding in the form of a tube at the open end in a normally hatched egg. The life-cycle of the parasite was found to be almost equal to the incubation period of the host-egg during March-April, *i.e.* 6 days. This species was, however, on the decline from May onwards.

Typhodytes sp —In the first week of May, adults of this scelionid appeared in the field along with the young nymphs of *Bagrada*, both emerging from the egg-clusters in the soil. The degree of parasitism noticed was 18-20% and the ratio of males to females was 2 : 3. In the laboratory, a single female parasitized 25% of the eggs laid by the bug outside the soil against 22% laid in the soil. The incubation period of the egg during May was 4-5 days, while the life-cycle of the parasite occupied 12 days. In the absence of the cruciferous plants, both the pest and this egg-parasite were observed breeding in the compost heaps in the neighbourhood to which they migrated. It appears that the fermenting materials in the compost, probably containing sweet substances, are capable of supplying the nutrition required by the pest. The pest as well as the second parasite were on the decline from early June.

New Delhi C. K. SAMUEL

Biology and distribution of *Chilo trypetes* Bisset in the United Provinces.

The occurrence of this borer in the United Provinces is mainly confined to both sides of the lower Siwalik ranges in the Dehra Dun and Saharanpur districts. The pest is monophagous and has been found to attack so far sugarcane only. Damage by this borer starts from the end of June and continues upto the end of August. The period of hibernation is from September to middle of June. First brood larvae (June-July) bore the cane shoot 3′-4′ above ground, and make a spiral round the place of their first attack. They enter the plant through eye-buds and travel upwards in stem making tunnels. Larvae of the second generation (August-September), however, do not bore upwards, but tunnel down towards the root. The pest has been found to be most serious in swampy localities and in the fields in which sugarcane was preceded by paddy. The varieties of cane most susceptible to the attack of this borer have been E K 28, CO 213, and CO 356, For control, the removal of cane stubbles after harvest is suggested.

A detailed account will appear later on.

Cawnpore B. D. GUPTA AND R. L. GARG

Relative incidence of Sugarcane borers at Cawnpore.

These observations, spread over a period of one and a half years, were taken at various times of the year. It was found that *Scirpophaga nivella* F. was by far the most abundant of all sugarcane borers found at Cawnpore. The period of its maximum activity appeared to be September-October. One relieving feature, which may be of considerable importance to local sugarcane growers was, that the mortality among the top-shoot borer larvae was very high due to various parasites. For instance, of the 150 larvae collected from different sugarcane fields during February 1942, hardly one fourth of these were healthy; the rest were in various stages of parasitisation.

The next in importance of occurrence was the stem-borer *Argyria sticticraspis* Hmpsn. It was found both in young as well as in old canes, but was more abundant in the young ones. Its incidence was relatively much low when compared with that of *S. nivella* F. *Emmalocera depressella* Swinh. was chiefly found in young canes and only occasionally in old canes. During January-February, 1942 it was rare in cane fields. A few caterpillars of *Sesamia uniformis* Dudgn. or *Sesamia inferens* Walk. were also collected from sugarcane crop during January-February. Unfortunately no pupa could be got out of these and therefore it is not possible to say to which particular species of the two they belonged.

The author has not been able to record any other sugarcane borer at Cawnpore so far.

Cawnpore P. L. CHATURVEDI

Biology and control of *Anthrenus vorax* Wat. at Cawnpore.

The species, *Anthrenus vorax* Wat. which belongs to the family Dermestidae, order Coleoptera is the commonest pest of animal fibres in India. The larvae which have a cylindrical elongate body covered with hairy processes are commonly known as 'Woolly Bears'. The larvae are the real pests whereas very little if any damage is done by the adult beetles. Every conceivable kind of woollen goods is damaged.

The female lays minute white fragile eggs which have been observed to hatch out in a month or so in March and April. The young larvae soon after hatching begin to eat and unless they are able to obtain their food quickly they soon perish. Grubs have successfully been reared in a dark chamber maintained at 80-95°F and 70-80% humidity.

Beetles and their grubs prefer dark and damp places. The essential food sought is keratin. If by chance, cellulose becomes the only edible material, the larvae sicken and die. The grubs fed upon various keratinous substances like wool, fur, feathers, hairs, hoofs and horns but showed marked preference for wool. The hygroscopicity of wool accounts for its preference by the larvae for it is an article of nourishment.

The indications of attack by the larvae of *Anthrenus vorax* Wat. are the identations or irregular spaces in the infested material, the presence of the dead or dying grubs, of pupal cases and of disintegrated fibres and hard dark pellets of the excrement of the larvae which drop away from the infested material when it is handled. A direct relation exists between the amount of uric acid excreted by the larva and the degree of attack.

The most effective way of preventing damage from the larvae of 'Woolly Bears' is by impregnating the individual fibres of woollen goods with a toxic solution. Dinitro–alpha–naphthol, eulan, and iron chromium solution are found to be the best for adoption. Exposure to light, cold storage, sterilization by heat and fumigation by hydrocyanic acid and paradichloro-benzene have proved successful. Part success in preventing damage has been achieved by using naphthalene balls and neem leaves and extracts.

Cawnpore S. L. PERTE

Lepidopterous pests of stored products in the Punjab.

Corcyra cephalonica Staint., *Ephestia cautella* Walk., *Stathmopoda trissorrhiza* Meyr. and *Sitotroga cerealella* Oliv infest bran, dried graps, "Anab" berries (*Zizyphus* sp) and wheat respectively. The first three are new to our collection.

Lyallpur KHAN A. RAHMAN

Effect of food on the longevity of *Tetrastichus pyrillae* Craw.

The adults of *Tetrastichus pyrillae* were confined on different flowers, honey dew produced by Pyrilla adult and nymphs and diluted honey during September and October. It was observed that they could survive for 16-21 days on Ratten jot (*Vinca rosa*) flowers, 7-13 days on honey dew and 2-11 days on flowers of *Quisqualis indica, Cosmos diversifolius; Verbena* sp,, *Brachycome iberidifolia, Petunia hybrida, Gossypium hirsutum* and *Ipomaea sinnata* and diluted honey.

Lyallpur PARTAP SINGH

Palarus sp. a new predator of bees at Lyallpur.

This wasp, which is a new enemy of *Apis indica* F., was recorded for the first time at Lyallpur in May 1940, when it was observed killing large number of bees every day. It attacks the bees with lightening rapidity and stings them into insensibility. It becomes active during summer especially in the hot and dry months and its activity may extend even upto the end of September. It visits the hives on hot and sunny days between 11 A.M. and 4 P.M.

Lyallpur PRITAM LAL SHARMA

NEW BOOKS AND MONOGRAPHS

Embryology of Insects and Myriapods. By O. A. Johannsen and F. H. Butt. Pp. i-xi+1-462. McGraw-Hill Book Co., New York & London, 1941.

The science of embryology has, from its very birth, remained peculiarly German. In the embryology of insects too, the outstanding contributions, both in the comparative and the experimental branches, are largely in German--starting from the pioneering studies of Suckow (1818), Kolliker (1842) and Bobretzky (1878), down to the extensive and elaborate works of the two great masters, Graber (1877-1891) and Heymons (1890-1912), in comparative embryology and of Professor Seidel and his Konigsberg school (1926-to date) in experimental embryology. Nearly 80 per cent of the extensive literature on the subject is in German. It is no wonder, therefore, that authoritative text-books have also all been written in that language. These are the well-known works of Korschelt and Heider (1892-1910) on Invertebrate embryology, the recent edition of this work by Korschelt (*Vergl. Entw. d. Tiere*, Bd. II, Jena, 1936). and the comprehensive account on "Embryogenese d. Insekten" by Hirschler (1924-1927) in Schroder's *Handb. d. Entomol.*, Bd. I.

The book of Johannsen and Butt is, therefore, welcome to those conversant with the English language only. It is divided into two parts. Part I deals with the general and comparative aspects of insect embryology. There are chapters dealing with fertilisation, maturation, cleavage, early development of the embryo, gastrulation and the formation of the germ layers, organogeny, polyembryony, parthenogenesis, and experimental embryology.

Part II deals in considerable detail with the embryology of one or more types in each of the orders of insects. Here we obtain some idea of the bewildering variety of the modes of embryonic development among insects, and of the great difficulty of satisfactory interpretation of some structures. On controversial issues, the general plan followed by the authors is to quote impartially the opinion of the various writers, leaving the reader to judge for himself the view to be adopted.

Many sections are, both in the textual matter and the illustrations, freely copied with acknowledgement, from other authors such as Richards and Miller, Heymons, Roonwal, Noskiewiz and Poluczyuski and others. The book would have acquired greater coherence if the authors had collated the matter in their own language and style.

Unnecessary and often confusing coinage of new terms is unfortunately very common in American entomological literature. The present authors have been unable to escape from that tendency. They have used strange names for some of the wellknown insect orders. For example, Oligoentomata and Aptilota are used for the Apterygote orders, and Oligonephridia for the Psocoptera, Anoplura, Thysanoptera and Hemiptera.

The bibliography of nearly 700 references greatly enhances the value of the book. A few errors that have come to my notice are mentioned below:

Hertwig, R. "*Sitzb f.* 1880" and "*Zeitschr. f. Naturwiss., Jena* 14: 124-128. 1881" cannot be traced. The reference is not in *Jena. Z. Naturwiss.* 14 & 15, 1880, 1881; nor in *Z. Naturwiss.*, Leipzig, 1880, 1881.

Nel 1930 should be 1929.

Newport 1851 should be 1847.

Nicholson 1821 should be 1921.

Patten 1888*b* should be 1889.

Pierentoni 1914: *Ermafrodatismo* is given as a periodical, but is really a part of the title of the paper.

Schrader, pp. 279-309 should be 279-302.

Silvestri 1907 should be 1906.

Snodgrass 1927 should be 1926.

Tichomiroff *Nature* 36, 1885 should be 31.

Tichomiroff 1900 should be 1890.

These are minor errors in an otherwise carefully compiled bibliography.

We are indebted to the authors for providing us with an indispensable and very dependable treatise on a difficult subject.

M. L. ROONWAL

NEWS AND ANNOUNCEMENTS.

L. Dina Nath Tandan is officiating as assistant to the Entomologist, Punjab Government since December 1941 *vice* Dr. R. L. Chopra who proceeded on medical leave.

In March, 1942 at the instance of the Iranian Government, the Government of India sent a Locust Delegation under the leadership of Dr. Taskhir Ahmad, Assistant Entomologist, I. A. R. I. to Iran to advise and demonstrate anti-locust measures. Majority of the members of the delegation were members of the Entomological Society of India. Besides studying the previous history of locust invasions and places of locust breeding and controlling locust on a large scale in Khuzistan province, the delegation has brought a large collection of insect fauna of that country which will be very useful to us in the future.

The I. C. A. R. sanctioned a scheme of work from the Ist April, 1942 for the study of the control methods of jowar pests in storage. The scheme is sanctioned for three years at the I. A. R. I. under the Imperial Entomologist and for one year in the Punjab, U. P., Bihar, C. P., and Madras under the respective provincial Entomologists.

Work under the Sugarcane Pests Scheme of the I. C. A. R. terminated on the 31st March, 1942 but a separate scheme on the biological control of the sugarcane borers was sanctioned from 1-4-42. at the I. A. R. I. and various provincial centres for 2 years. Field experiments to test the efficacy of *Trichogramma* are to be conducted in Bhopal, Orissa, Bengal, (Setabganj) under the direct control of the Biological Control Research Officer and in the Punjab, U. P., Bihar, Bombay and Madras under the respective provincial Entomologists. Dr. Taskhir Ahmed took over charge of B. C. R. O.

Coordinated scheme of Anti-Locust work under the Imperial Entomologist came into operation from May, 1942. All provinces and states in North West India are to carry out control work on a co-operative basis.

Dr. E. S. Naryanan, M. Sc., Ph. D. (London) has been appointed as officiating Assistant Entomologist, I. A. R. I. *vice* Dr. Taskhir Ahmed.

Mr. B. B. Bose has been appointed as officiating Second Assistant Entomologist *vice* Dr. E. S. Narayanan.

OBITUARY

Dr. R. L. Chopra, a foundation member of the Entomological Society of India, passed away on the 10th April 42, after a short illness at his residence at Lahore at the early age of 47.

Dr. Chopra took his M.A. degree in 1917 from the Government College, Lahore, after which he proceeded to England for higher studies. He earned Ph. D. in Entomology from Aberystwyth, Wales in 1923 and joined the Entomological section of the Punjab Agricultural College, Lyallpur in August 1925.

He was mainly engaged in teaching entomology to agriculture students, and officiated as Entomologist to Government Punjab, on several occasions. He leaves behind a large number of friends and relations to mourn his loss.

PROCEEDINGS OF THE ENTOMOLOGICAL SOCIETY OF INDIA

NEW DELHI BRANCH

19th January, 1942

Dr. H. S. Pruthi was unanimously elected President of the Branch Society.

Exhibits—

Dolycoris indicus Stal. on *Sesamum indicum*	M. BOSE
An interesting coccid on rose at Delhi	K. K. NIRULA

Communication—

On San Jose scale and woolly aphis in Kashmir	A. P. KAPUR

24th February, 1942

Exhibits—

The weevil, *Microlarinus rhinocylloides* and its parasites	GHULAM ULLAH
Potato hopper-burn by *Empoasca punjabensis*	E. J. VEVAI

Communication—

On the scope and aims of studies on insect population	S. PRADHAN
On fresh water Trichoptera	P. J. DEORAS

22nd May, 1942

Exhibits—

Ichneumonid parasite of *Heliothis armigera*	MOHAN SINGH
Sathrophylla sp. on jowar	K. R. SONTAKAY

Communication—

Some of the drawbacks in the present method of controlling fly breeding	K. K. NIRULA
Locust situation in Iran	TASKHIR AHMAD
Boring habits of the sugarcane borer, *Argyria sticticraspis*	A. R. PANDA
A few observations on *Apis dorsata*	K. R. SONTAKAY

U. P. BRANCH—CAWNPORE

18th February, 1942

General—

Dr. K. B. Lal and Mr P. L. Chaturvedi were elected respectively President and Secretary of the Branch Society for 1942

Communication—

Biology and distribution of *Chilo trypetes* Bisset in the United Provinces .. .. B. D. Cupta & R. L Garg

Exhibit—

Dichocrocis punctiferalis Guen. as borer of mango inflorescence at Benares .. .. K. M. Gupta

27th May, 1942

Exhibits—

Grubs of *Anthrenus vorax* Wat. .. .. S. L. Perti

Nests of mango leaves made by *Oecophylla smaragdina* F. .. .. .. K. B. Lal

Communication—

A short note on the biology and control of *Anthrenus vorax* Wat. at Cawnpore .. S. L. Perti

A short note on the relative incidence of sugarcane borers at cawnpore .. .. .. P. L. Chaturvedi

PUNJAB BRANCH—LYALLPUR

25th November, 1941

Exhibit—

Tetrastichus pyrillae Craw. .. .. Partap Singh

Communication—

Biology of *Bruchus analis* F. & *Bruchus chinensis* L. A. N. Sapra

30th January, 1942

Exhibit—

Lyctes africanus Lesne and its parasite .. Gurcharan Singh Sohni

Communication—

The Lemon butterfly .. .. .. Dina Nath Tandon

25th February, 1942

Exhibit—

Grubs of *Attagenus piceus* Oliv. .. .. A. N. Sapra

Communication—

Further studies on maize borer .. .. Anshi Lal

25th March, 1942

Exhibit—

Palarus sp. .. .. PRITAM LAL

Communication—

Bee-keeping in the plains .. .. PRITAM LAL

30th April, 1942

Exhibit—

Tarache lucida Hubn. .. .. .. M. A. GHANI

Communication—

The Citrus leaf-miner .. .. .. MOHD. YUNIS

A NEW SPECIES OF TRICHOSPILUS (*HYM : CHALCIDOIDEA*) FROM SOUTH INDIA.

By M. C. CHERIAN and V. MARGABANDHU,
Agricultural Research Institute, Coimbatore.

The genus *Trichospilus* was erected by Ferriere* in 1930 with *T. pupivora* as the type-species. Since then no other species has been described. Recently the authors came across another species which is described below.

TRICHOSPILUS DIATRAEAE, sp. n.

Female.—Length about 1.864 mm. General colour yellowish brown. Eyes dark heavily inlaid with red pigmentation; two brown streaks extending from the posterior end of the eyes to almost near the mouth also with red pigmentation. Antennae with scape and pedicel yellowish brown, rest pale, club tipped hyaline. Legs yellowish brown except the fore and middle coxae, basal halves or thereabouts of all femora hyaline, hind coxae yellowish grey shaded dark at outer extremities. Wings shaded grey in the distal half, a greyish band across in the middle, shaded lightly at base, and shaded deep in the region of the two tufts of spines. Abdomen yellowish grey with a dark brown circular patch in the middle towards the base.

HEAD.—

Length 0.500 mm., transverse, broad anteriorly and narrowly rounded posteriorly. Eyes large, occupying 0.6 the length of head and 2.4 times as long as broad, distance between the two inner margins of eyes 0.282 mm. Two lateral ocelli placed farther apart. Antennae 9—jointed as follows: a scape, a pedicel, two ring-joints, two-jointed funicle, and a three-jointed club; scape narrow, long, 5.5 times as long as broad and longer than the club; pedicel 2.3 times as long as broad and almost half as long as the club; ring-joints short and transverse; first funicle slightly longer than the second and the two are subquadrate; the club elongated, narrowed at apex and 1.5 times longer than the funicle and almost twice as long as the pedicel.

THORAX.—

Length 0.755 mm. Thorax with long scattered bristles. Pronotum narrowing forwards into a neck with dense irregular transverse reticulation; mesonotum densely reticulated; parapsidal furrows distinct; scutellum slightly narrowed and rounded at apex and broadly arched in front of the postscutellum, whole of the scutellum finely, densely longitudinally striated, striations complete towards the sides and incomplete in the middle; postscutellum broad in the middle and broadly rounded behind; propodeon with a median carina and two lateral spiracles Wings long, broad, 2.6 times as long as broad; two tufts of spines, one below the submarginal vein and the other below the base of the marginal vein, the former with six small and the latter with more than 30 long spines scattered near each other; marginal vein with 10 long spines and the

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*Ch. Ferriere. Bull. ent. Res., 1930, **21** : 358-359.

submarginal vein with 5 longer and prominent ones; postmarginal vein not well developed and with 2 spines; stigmal vein distinct, with a developed club. Legs with hind coxae swollen and reticulated, hind femora slightly broader than the rest; middle tibial spur long.

Abdomen.—

Length 0.573 mm. Rounded and broad and slightly broader than thorax. Petiolus short.

Holotype.—One female on slide. (Deposited in the A. C. R. I. collections,) Coimbatore.

Paratypes.—Several females in spirits and on slides.

Host:—*Diatraea venosata* Walk: internal parasite of pupa. Only one pupa was obtained parasitised, (Coimbatore, xii 1939, C. K. Subramaniam, coll.)

The new species has all the characters of the genus It can easily be distinguished from *T. pupivora*, Ferr., the only other known one, chiefly: (i) in the coloration and measurements of antennal joints; (ii) sculpture of scutellum; (iii) wing shade and variation in the number of spines constituting the two tufts of spines and their mode of disposition on the wings (figs. 1 and 2); (iv) abdominal coloration; and (v) in the general measurements of the constituents of the body. The adults in the case of the new species are of a lighter hue and larger build.

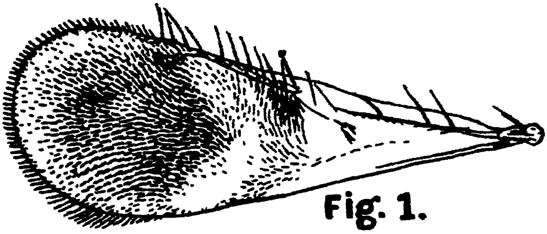

Fig. 1.

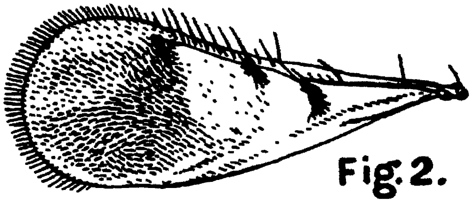

Fig. 2.

Fig. 1. Forewing of *Trichospilus diatraeae*, sp. n. (♀)
Fig. 2. ,, *Trichospilus pupivora*, Ferr. (♀)

ON LARVAE OF CERAMBYCIDAE (COLEOPTERA)

By J. C. M. Gardner,
Forest Research Institute, Dehra Dun.

This paper is in continuation of others (see list of references) on larvae of Indian Cerambycidae. Subfamily characters are now discussed together with an account of larvae of *Prioninae, Aseminae* and *Lepturinae.*

SUBFAMILY CHARACTERS.

The keys given by Craighead (1923) and by Boving and Craighead (1931) are based on North American species and examination of Indian material shows that some modification is necessary. Larvae of American Prioninae (except *Parandra*) have the epistoma projecting over clypeus and the frons carinate or dentate; but in the Indian genera *Macrotoma* and *Sarmydus* those two parts are simple, very much as in *Parandra*. In Lepturinae the epicranial halves are stated to be separated behind frons, but in *Leptura rubriola* the posterior emargination is quite distant from the frons, the intervening space depressed (Gardner 1927, pl. 1, fig. 3) also in *Necydalis* (as Craighead notes) the epicranial halves are fused for some distance behind the frons.

KEY TO SUBFAMILIES.

1. Mandibles short with gouge-like distal cutting edge which is not angulately produced on lower side. Clypeus narrow, not filling space between dorsal mandibular articulations..CERAMBYCINAE.

—. Mandibles with distal cutting edge oblique. Clypeus wide, filling space between mandibles..2.

2. Head oblong. Legs absent or vestigial..LAMIINAE.

—. Head transverse (slightly longer than wide in *Logaeus*). Legs distinct............3.

3. Submentum attached to skin of prothorax, the antero-ventral margin of head concealed. (Posterior foramen of head postero-dorsal)............DISTENIINAE.

Skin of submentum not continuous with that of prothorax, the hypostomal region of head exposed..4.

4. Ventral surface of head with a small anterior and a larger posterior foramen separated by the tentorial bridge..PRIONINAE.

Tentorial bridge not on same plane as ventral surface of head, hence no anterior foramen is visible..5.

5. Posterior emargination of head deep, often extending to frons. Body form subcylindrical to strongly depressed. With or without caudal armature..LEPTURINAE.

Posterior emargination of head very shallow. Body subcylindrical, with two caudal points..ASEMINAE.

Prioninae.

Larval characters of this Subfamily, with special reference to North American species, are discussed in detail by Craighead (1915, 1923); certain Indian species have been described by Beeson (1919) and by Gardner (1927, 1931).

Subfamily characters —Head transverse to slightly longer than wide; dorsal margins of epicranial halves fused behind frons, separating or not near the base (*i.e.* there may be a small basal emargination); the tentorial cross-arm is on the same plane as the ventral surface of the head, hence there is a smaller anterior perforation in addition to the large posterior foramen. Mandible with the distal edge oblique, with acute apex. Clypeus as wide at base as epistoma. Abdominal ampullae with two transverse impressed lines dorsally and one ventrally. Legs distinct.

The anterior margin of the frons may be carinate or dentate and the epistoma may have dentate projections over clypeus; on the other hand these parts may be quite regular. The antennal ring is often produced into a shield above the antenna (*Macrotoma* and *Sarmydus* are exceptions) and it is usually a rigidly sclerotized socket but this may be reduced ventrally as in *Sarmydus*. The antenna with two large basal segments and with or without a third very small segment; a membranous basal connecting skin is not considered as a segment.

The presence or absence of a small third antennal segment in the mature larva seems to be of major importance in separating two groups of tribes; unfortunately it is not mentioned in some descriptions. But it should be noted that where the mature larva lacks the third segment, the latter may be present in small larvae of the same species; this is so at least in the case of *Macrotoma crenata*.

Correlation of adult and larval classification.—Lacordaire's groups Macrotomides (=Macrotomini) and Remphanides (now referred to as Raphipodini since *Remphan* is at most a subgenus of *Raphipodus*) were put together by Gahan (1906 Fauna of Brit. India 1 : 29) in the tribe Macrotomini and also by Lameere (1912, Mem. Soc. Ent. Belge 21 : 180). The larvae of *Macrotoma* and *Raphipodus* show differences which support Lacordaire's conception rather than Gahan's.

The genus *Acanthephorus* is in Lacordaire's group Acanthophoridae (=Acanthophorini Gahan) which however is treated by Lameere (t. c. p. 182) as a tribe of the Prionini. Here again larval evidence is in favour of Lacordaire's arrangement.

KEY TO GENERA.

1. Antenna with 3 segments, the apical one very small..2.
—. Antenna with only 2 segments, with no small apical segment..........................4.
2. Frons with smooth, non-carinate anterior margin; epistoma not produced over clypeus. (Anacolini)..SARMYDUS.
—. Frons with a transverse anterior carina. Epistoma usually produced..............3.
3. Head with three distinct ocelli on each side. Labrum about as long as wide, cordate (Callipogonini)..MEGOPIS.
—. Head with one or no ocelli on each side. Labrum more transverse, ovate (Prionini)..PRIONUS, LOPHOSTERNUS, LOGAEUS.
4. Frons even and not carinate anteriorly; epistoma not produced over clypeus. (Macrotomini)..MACROTOMA.
—. Frons with transverse carina anteriorly; epistoma produced over clypeus at lateral angles..5.
5. 3 distinct ocelli on each side (Raphipodini)..............................RHAPHIPODUS.
—. No ocelli (Acanthophorini)..ACANTHOPHORUS.

Macrotomini.

M. (Zooblax) plagiata Waterh.—Beeson, 1919 : 103 pl. 1 f. 1-6 (Larva)—Gardn. 1927 : 33.

M. (Zooblax) crenata Waterh.—Beeson, 1919 : 106, (larva, pupa).

Larval exuviae of *M. (Z) aeneipennis* Waterh. taken with pupae from rotten wood, Anaimalai Hills, Madras (J. C. M. G.) show structures very similar to those of the other two species of *Macrotoma*.

Rhaphipodini.

Rhaphipodus (Remphan) hopei Waterh.—Beeson 1919: 108, pl. 2, f. 1-6 (Larva, egg, pupa).—Gardn. 1927 : 33.

Larvae of *Rhaphipodus* sp. from Burma and larval exuviae of *Rhaphipodus gahani* Lmre. from Dehra Dun both show great resemblance to *R. (Remphan) hopei*.

Acanthophorini.

Acanthophorus serraticornis Ol.

Larva.—Head moderately transverse with a small postero-median emargination; frons with sharp anterior carina, epistoma produced at lateral angles over clypeus (the projections stronger in a small larva than in two full-grown larvae); one ridge above antenna and two below it; a distinct tooth near ventral condyle. Labrum transversely ovate, rather sparsely pubescent on anterior half. Antenna without a small apical segment. Mandible with oblique cutting edge, with a distinct tooth at base near dorsal condyle. Ocelli not distinct. Pronotum irregularly rugulose. Eusternum open anteriorly. Skin smooth and shining, setae sparse and very short. Body stout. Length about 100 mm.; width of head 16 mm.

Larvae were sent alive from Gurdaspur, Punjab with the report that they were seriously damaging roots of roadside trees of *Dalbergia sissoo* ; one beetle was reared at Dehra Dun. Some biological notes on this species are given by Beeson and Bhatia (1939 *Indian For. Rec.* (*Ent*) 5 : 14).

Callipogonini.

Megopis Baralipton cingalensis Wh.—Gardn. 1931 : 165.

M. (*Dinoprionus*) *cephalotes* Bates.—Gardn. 1931 : 164, f. 4.

M. (*Agosoma*) *tibialis* Wh.—Gardn. 1931 : 164, f. 1-3.

M. (*Aegosoma*) *sinica* Wh.—Kojima 1931 : 264, 5 figs.

Larvae of known species are separable as follows :

1. Epistoma not produced over clypeus at lateral angles. Ampullae and posterior zone of pronotum dull (very finely granulate)..................CINGALENNIS Wh.

—. Epistoma acutely produced over clypeus at each lateral angle. Ampullae and pronotum not finely granulate..2.

2. Frontal carina strong, with abrupt median knotch..................................3.

—. Frontal carina moderate, with slight median knotch. (Epistomal teeth strong, very wide basally)...CEPHALOTES Bates.

3. Epistomal teeth strong, (Head with more black pigmentation anteriorly) ....BUCKLEYI Gah.

—. Epistomal teeth weak. (Head with dark pigmentation reduced)......TIBIALIS Wh.

The larva of *M. sinica* Wh. as described by Kojima, appears to resemble *M. buckleyi*.

M. (*Aegosoma*) *buckleyi* Gah.—One larvae and two beetles were extracted from dead wood, Almora, U.P. (J.C.M.G.).—The frontal carina is more strongly raised than in the other species, is slightly sinuate and more prominent on each side of the deep median knotch. The head anteriorly has much black sclerotization. Length about 65 mm. In larvae of this genus the frontal suture passes very close to the antenna, the antennal ring being therefore extremely narrow ventrally.

The larva previously described as *M. cingalensis* Wh., was taken in Madras; the associated female beetle is covered by Gahan's description. Since then other larvae, with female beetles, were collected in Ceylon. These larvae resemble that described as *cingalensis* in having no epistomal projection and granulate prothorax and ampullae; but the granules are much stronger. The beetles differ somewhat from the specimen I determined as *cingalensis* but Mr. J. G. Arrow tells me that they resemble females associated with that species by Gahan in the British Museum.

Prionini.

Dorysthenes (*Lophosternus*) *hugeli* Redt.—Beeson 1919: 15; Gardn. 1927: 33.

Logaeus subopacus Waterh.—Beeson 1919: 116.

Prionus corpulentus Bates.—Gardn. 1927: 32.

KEY TO SPECIES.

1. One ocellus on each side of head. Head not emarginate posteriorly..LOGAEUS SUBOPACUS Waterh.

—. Without ocelli. Head with abrupt posterior emargination..........................2.

2. Frontal carina heavy, obtuse, with very distinct median emargination..PRIONUS CORPULENTUS Bates.

—. Frontal carina fine, not strongly raised, with at most a weak median emargination..LOPHOSTERNUS.

Lophosternus socius Gah.—Beetles were reared from *Cryptomeria japonica*, Darjeeling (J.C.M.G.). Two associated larvae are very similar to *hugeli*.

Lophosternus hugeli Redt. In the first stage larva, the spiracles are biforous, each with two small contiguous lobes that project slightly beyond the peritreme; the frontal carina is weak but distinct; the epistoma projects rather irregularly over clypeus; the ampulla with minute skin-points. Length about 6 mm.

Anacolini.

Sarmydus subcoriaceus Hope. Larva.—Head distinctly wider posteriorly, slightly wider than long; posterior margin not emarginate; black at mandibular articulations, the epistomal margin and dorsal part of antennal ring narrowly castaneous. Frons not carinate anteriorly; epistoma not produced over clypeus. Antennal ring not produced as a shield over antenna, incomplete ventrally. A small tooth near ventral articulation of mandible. One distinct ocellus on each side. Antenna three segmented, the apical segment very small, a little longer than wide. Labrum about twice as wide as long, broadly curved anteriorly, the surface with not very dense hairs. Mandible with cutting edge oblique acute at apex and rectangular at posterior extremity. Prothorax above anteriorly testaceous, posteriorly soft, and rugulose. Eusternum triangular, with complete margin. Abdominal ampullae rather protuberant. Anus trilobed. Length of larva about 40 mm.

Larvae were taken from *Quercus incana*, *Alnus nitida* and *Pieris ovalifolia*, Almora and Garhwal U.P. (J.C.M.G.) ; beetles were reared.

This larva closely resembles that of Japanese species *Psephactus remiger* Harold as described by Kojima (1931) ; the latter larva, however, has no ocelli.

Aseminae.

Larvae.—Head transverse the posterior margin nearly straight, at most only very shallowly emarginate ; tentorial cross-arm internal (in consequence there is no small anterior subdivision of the foramen such as is present in *Prioninae* and *Cerambycinae*). Antennal ring distinctly open to frontal suture. Clypeus wide, filling dorsal space between the mandibular condyles. Labrum transverse or not. Mandibles with oblique apical edge of which the lower extremity is acute. Eusternum of prothorax distinct, triangular. Legs moderately long. Spiracles with two or more small marginal air-chambers. Posterior zone of prothorax and the ampullae, with dull surfaces (*i.e.* microscopically asperate) ; ampullae without tubercles. Ninth abdominal segment with two small caudal points. The larvae live in wood of *Coniferae.*

KEY TO GENERA.

1. Labrum strongly transverse (Posterior margin of hypostoma strongly concave. hence gular region short. Caudal points more approximate........................2.

—. Labrum as long as wide. cordate (Hypostomal region only slightly narrowed medially. Caudal points well separated)..............................CRIOCEPHALUS.

2. Thoracic spiracle about twice as large as that on first abdominal segment ....TETROPIUM.

—. Thoracic spiracle small. not much larger than the first abdominal ....NOTHORHINA.

Criocephalus.

Larvae.—Labrum cordate, narrowed apically, as long as wide. Hypostoma only slightly narrowed in gular region where there are two fine narrowly separated raised lines. Mandible acutely produced at apex. Maxillary mala narrow. Caudal points well separated. Spiracles with three or more contiguous air-tubes on posterior margin ; thoracic spiracle large, about three-fifths as wide as labrum and about twice as wide as that on A1.

The larva of *Criocephalus tibetanus* Sharp was previously described (Gardner 1927 : 36) ; the spiracles in this species have several marginal air-tubes which occupy a relatively small part of the margin ; on the prothoracic spiracle there are about eight small contiguous and inconspicuous chambers ; on the abdominal spiracles about twelve, more conspicuous.

Criocephalus unicolor Gah.—The larva closely resembles *C. tibetanus,* but the mandible is still more acute at the apex, the genal setae are relatively longer, and the marginal air-chambers are fewer, three on each spiracle, in the specimen examined; caudal points fine, acute; also the larva is much smaller; length about 14 mm.

Larvae from *Pinus khasya*, Myitkyina, Burma.

Nothorhina gardneri Plav.

Larva.—This species has much in common with *Tetropium oreinum* Gah. (Gardner 1927 : 35); the labrum is distinctly transverse; the hypostomal region is strongly narrowed at the gula; the mandible is moderately acute at the apex (much less so than in *Criocephalus*); the spiracles have two or three marginal air-tubes; the caudal points are much more approximate than in *Criocephalus*. But in *N. gardneri* the thoracic spiracle is relatively small not much larger than spiracle A1 and about one-third as wide as labrum whereas in *T. oreinum* the thoracic spiracle is large, about twice as large as the spiracle on A1 and more than half a wide as the labrum. Length of larva about 18mm.—Larvae and adults from *Pinus longifolia*, Dehra Dun (J. C. M. G)

Lepturinae.

Head strongly to moderately transverse; the epicranial halves either entirely or only partly separated behind frons; tentorial cross-arm internal (*i.e.* not in same plane as hypostoma and separating a small anterior perforation from the foramen). Clypeus filling dorsal space between mandibles. Ocelli one, three or absent. Antenna small (larger in *Necydalis*). Mandible with oblique cutting edge, apex produced. Eusternum of prothorax distinct, triangular. Legs well developed for the family. Spiracles with a number of small contiguous marginal air-chambers. Body skin not micro.asperate. Ampullae tuberculate. Body form subcylindrical to strongly depressed. Craighead (1923) and Boving and Craighead (1931) have used the entire separation of the epicranial halves behind the frons as a major character to define the subfamily; this requires modification for in *Leptura rubriola* and *Teledapus* for example, the epicranial halves are fused for most of their length, hence leaving only a comparatively small (but quite distinct) basal emargination of the head.

The very highly modified larvae of *Apiocephalus* and of *Capnolymma* spp. have already been described (Gardner 1931 : 110). Since then the larva referred to as "*Capnolymma Larva A*" has been proved to be *C. cingalensis* Gah. as Dr. N. C. Chatterjee has provided a reared beetle of that species together with associated larval exuviae.

Key to genera of Lepturinae.

1. Epicranial halves entirely separated behind frons. Larvae very depressed and of unusual form. Head with marked lateral and anterior angulations. Three ocelli on each side. First eight abdominal segments each with a strong process on each side..........2.

—. Epicranial halves only partly separated, hence the posterior margin of head with an emargination of only moderate depth. Larvae not depressed; head and body normal. Not more than one ocellus on each side..........3.

2. Prothorax with two lateral teeth on each side. Head more bluntly angulate laterally..........APIOCEPHALUS.

—. Prothorax without lateral teeth. Head more sharply angulate....................CAPNOLYMMA.

3. Ninth abdominal segment produced into a strong depressed-conical caudal process which bears at its apex two pairs of small points, one pair above the other............TELEDAPUS.

—. With no caudal armature............4.

4. Mandible acutely and abruptly produced at apex. Ampullae with well defined tubercles arranged in transverse rows. One ocellus on each side of head............LEPTURA.

—. Mandible shorter, the apex not abruptly produced. Ampullae closely covered with very small soft tubercles. No ocelli............NECYDALIS.

Teledapus doreadioides Pasc.

Larva.—Body nearly cylindrical, slightly widened at thorax, tapering posteriorly to a conical projection. Head yellowish, the extreme anterior margin blackish. Body hairs fine, sparse. Length up to 40 mm.

Head moderately transverse, widest behind the middle narrower apically; epicranial halves fused for some distance behind frons then diverging near beas causing a distinct emargination. There is no differentiation of the gula. There is a trace of a weak carina just above epistomal margin. A small fairly distinct ocellus on each side. Antennal ring distinct above but not below the antenna where the frontal suture (which is not clear elsewhere) passes it tangentially. Antenna salient, with large basal skin; basal segment elongate, second transverse bearing a conical accessory appendage as well as the small third segment. Labrum and clypeus both strongly transverse, tormae very short, extending caudad from extreme lateral angles of labrum. Mandible with cutting edge oblique, concave, acute at apex. Maxillary mala broad Prothorax with dorsal surface testaceous anteriorly, soft and weakly wrinkled posteriorly; eusternum triangular, completely defined. Dorsal ampullae of first seven abdominal segments each with two transverse impressed lines and four fairly regular rows of rather large smooth tubercles which are usually separate from one another; there are a few similar tubercles on metanotum. Two transverse rows of tubercles are present ventrally on T2, T3, and A1 to A7. The ninth segment is produced into a strong, fleshy, depressed-conical horizontal procss above and considerably beyond the anus; this process terminates in two pairs of points, one pair above the other; the dorsal points more widely separated, the ventral points fused basally, the separate apices smaller. Legs with four segments and a basal coxal lobe. Spiracles with a series of contiguous air-tubes (about seventeen on A1) occupying the greater part of the posterior margin. There are no asperities or skin-points on the body skin.

Larvae and beetles from decaying trees and stumps of *Abies pindrow, Cedrus deodara* and *Picea morinda*, Chakrata U P. (J. C M. G.)

Necydalis indicola Gardner.

Larva.—Body slightly depressed and widened in thoracic region, abdomen nearly cylindrical, slightly widened from A6 to A8 where the epipleura are protuberant; anal segment small, terminal, trilobed. Colour white except extreme anterior margin of head which is castaneous. Length up to about 20 mm.

Head distinctly wider than long, the sides broadly rounded; epicranial lobes fused for a considerable distance behind frons, then separating, leaving a distinct basal emargination ; the parallel gular sutures are distinct, raised anteriorly ; the antennal ring is fine and pigmented dorsally but is broken laterally, apparently, due to the frontal suture (not distinctly defined elsewhere) passing very close to the antennae ventrally. Ocelli are not distinct. Antenna rather large with second segment stout, moderately elongate; third segment stout, subglobular ; accessory appendage conical. Labrum about twice as wide as long, oval. Mandible oblique distally, the apex subacute and projecting beyond the remainder of the cutting edge which is rather feebly angulate at each extremity ; a few oblique striae are present internally at the apex. Maxillary mala broad. Pronotum soft and wrinkled posteriorly, smooth anteriorly but not pigmented ; eusternum triangular and distinctly defined. The ampullae are covered with very small, closely placed and smooth tubercles, irregularly arranged ; dorsally ampullae are found on A 1 to A 7 where only the anterior depressed line is fairly distinct and ventrally on T2, T3 and A 1 to A 7. There is no caudal armature. Legs moderately large, soft, with four free segments. Spiracles with about six contiguous air-tubes, situated on dorsal margin slightly projecting beyond peritreme. The skin is for the most part smooth but patches of microscopic skin-points are present in certain areas (*e.g.* eusternum).

Larvae, pupae and beetles from dead wood of *Quercus incana* and *Q. semecarpifolia*, Chakrata, U. P. (J. C. M. G)

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A CONTRIBUTION TO OUR KNOWLEDGE OF INDIAN THYSANOPTERA

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INTRODUCTION

The order Thysanoptera has received serious attention in India only since 1915, and between this year and 1925 most of the work on Indian Thysanoptera was done by foreign specialists, such as Karny, Priesner, Bagnall, Hood, Williams and Moulton. A number of species, collected from Ceylon by Uzel in 1905, were described by Schmutz in 1913. Since 1925 Ramakrishna Ayyar has extensively studied the group and published numerous papers.

Descriptions of Indian thrips by some of the earlier workers are rather inadequate for diagnostic purposes and some are even inaccurate in several respects. Very often species described by different authors at about the same time, working far away from each other, resulted in the same species being given several names, thus causing very great confusion of synonyms. It was therefore considered very desirable that whatever is known already should be properly systematised; and the Imperial Entomologist asked the author to undertake this work as part of his course in Entomology at the Imperial Agricultural Research Institute, New Delhi.

An attempt has been made by the author to elucidate synonymies and to revise the genus *Anaphothrips* Uzel. Three new species from north India are described, for one of which a new genus is proposed, and for each of the other two, a new subgenus. Two new genera are also erected to accommodate some known species, which are at present misplaced. Notes on some inadequately described species and redescriptions of a few incorrectly described ones are included.

This work was carried out in the laboratory of the Imperial Entomologist during 1940-41, and is mainly based on a study of the material in the collections of the Zoological Survey of India, Indian Museum, Calcutta and of the Imperial Pusa Collection in addition to that collected by the author and his friends in different parts of north India.

The author takes this opportunity of recording his gratitude to Dr. Hem Singh Pruthi, Imperial Entomologist, New Delhi for facilities for work and constant encouragement, to Dr. Baini Prashad, Director, and Dr. H. A. Hafiz, Entomologist, Zoological Survey of India for placing the Indian Museum collection at his disposal and for numerous other courtesies. Sincere thanks are also due to Mr. M. S. Mani, Imperial Agricultural Research Institute, New Delhi for many useful suggestions in technique of systematics.

The present paper deals with the suborder Terebrantia only and includes the following :—

1. *Aeolothrips fasciatus* (Linn.)
2. *Neocorynothrips asiaticus* Ramakrishna and Margabandhu.
3. *Ramakrishnothrips*, gen. nov.
4. *Pruthiella*, gen. nov.
5. *Neolimothrips brachycephalus*, gen. *et.* sp. nov.
6. *Dendrothripiella (Projectothripoides) pandai*, subgen. *et.* sp. nov.
7. Subgenera of *Anaphothrips* Uzel.
    - (a) *Hemianaphothrips* Priesner.
    - (b) *Pseudoarticulella*, nom. nov. (for *Anaphothrips* of Karny, *nec.* Uzel).
    - (c) *Dantabahuthrips*, subgen. nov.
    - (d) *Chaetanaphothrips* Priesner.
    - (e) *Anaphothrips* Uzel, s. str.
8. *Hemianaphothrips palmae* Ramakrishna.
9. *Anaphothrips (Dantabahuthrips) sacchari*, subgen. *et.* sp. nov.
10. *Anaphothrips flavicinctus* Karny.
11. *Anaphothrips hemavarna* (Ramakrishna and Margabandhu).
12. *Frankliniella intonsa* (Trybom)
13. *Euphysothrips* Bagnall
14. *Thrips (Oxyrrhinothrips) beharensis* (=*rostrata*) Ramakrishna and Margabandhu.
15. *Fulmekiola sacchariclda* Ramakrishna and Margabandhu.
16. *Deuterobrachythrips* Schmutz.
17. *Gnomonothrips coimbatorensis* Ramakrishna and Margabandhu.

AEOLOTHRIPOIDEA Hood, 1915

AEOLOTHRIPIDAE Uzel, 1895

Aeolothrips fasciatus (Linn.)

1761. *Thrips fasciata*, LINNE, *Fauna Svetica*, 266.
1836. *Aeolothrips fasciata*, HALIDAY, *Ent. Mag.* **3** : 451.
1919. *Aeolothrips fulvicollis*, BAGNALL, *A. M. N. H.* Ser. (9) **4** : 253 (new synonymy).
1928. *Aeolothrips fasciatus*, PRIESNER, *Die Thysanopteren Europas*, 105-108.

Bagnall distinguishes *Aeolothrips fulvicollis* from *Ae. fasciata* (Linn.) as follows :—

"The pronotum instead of being of the same colour as the head and the body, is much lighter, being of a yellow to yellowish brown colour. The fore legs are only present in one example, and are much lighter than the intermediate and hind pairs of legs. The dark and light areas of the fore wing are roughly sub-equal in extent.

"The head is as long as the prothorax and has the cheeks more strongly arched. In *Ae. fasciatus* the third antennal joint is longer than the fourth, in this species it is the same length (excluding the pedicel) or slightly shorter. (16 : 16 in one specimen and 15 : 17 in two.)

"The small setae on the longitudinal vein of fore wings are fewer, very minute, being 0·5 to 0·3 the length of the corresponding setae in *Ae. fasciatus,* lighter coloured, and therefore more inconspicuous."

An examination of about twenty-five male and female specimens from North India, showed variation in colour from almost uniform reddish-brown to greyish-brown more or less suffused with yellow especially on the prothorax abdomen and legs. In many specimens the fore legs were as dark as the other two pairs, in some cases they were lighter and more yellowish as is the case in *Ae. fulvicollis* Bagn, There were some specimens intermediate in this respect between these two cases.

The relative lengths of the 3rd and the 4th antennal segments bear no correlation to the above variation in body color. Their proportions vary within wide limits among males and females severally and together. A male and female *in cop.* had the following lengths (in Microns) :

Antennal segment ..	..	III		IV
Male ..	..	95	:	84
Female ..	..	103	:	106

Thus while in this male the 3rd segment was longer than the 4th, the opposite was the case in the female, this proportion was found to vary even in the two antennae of the same specimen.

From the fact that the material at the disposal of Bagnall at the time he erected the species, was rather scanty and in an ill state of preservation, not much reliance can be placed on the remaining characters mentioned by him. In fact, the dark and light patches of the forewing do not at all differ in extent in the so-called two species, nor is the head significantly different.

Bagnall had hinted in a letter to Priesner * that his Indian species *Ae. fullvicollis* was probably identical with a colour variety of *Ae. fasciata,* which was named as *collaris* by Priesner. The present author, however, is convinced that both belong to a single species and hardly merit being separated even as different varieties—they so imperceptibly grade into each other, and that therefore *Ae. fulvicollis* Bagnall is only a synonym of *Ae. fasciata* (Linn.)

Under the name *Ae. fulvicollis* Bagnall, this species has hitherto been reported to occur on *Verbascum* flowers at Cawnpore and Dehra Dun, and, on flowers of mango at Pusa. It is here recorded from flowers of sweet-peas (*Lathyrus odorata*), *khesari* (*Lathyrus sativus*), *sarson* (*Brassica campestris* var *sarson)*, *toria* (*Brassica campestris* var. *dichotoma*) and safflower (*Carthamus tinctorius*) ; on leaves of sugarcane and wheat ; and on flowers and leaves of lucerne (*Medicago sativa*) at Delhi mostly during the cooler part of the year. It has been collected on berseem (*Trifolium alexandrinum*) at Pusa. Males were observed to appear only in December and January when fertilised eggs are probably laid, which may be more suitable for tiding over the spell of cold.

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* *Die Thysanopteren Europas*, p. 103, 1928.

THRIPOIDEA Hood 1915

THRIPIDAE Uzel, 1895

CHIROTHRIPINAE Karny, 1921

Neocorynothrips (Ramk. & Marg.) Shumsher

1939. *Neocorynothrips*, Ramakrishna & Margabandhu, *Rec. Ind. Mus.*, **41** (4) : 21,22.

1940. *Neocorynothrips*, Ramakrishna & Margabandhu, *Cat. Ind. Ins.*, 25 : 4.

Ramakrishna and Margabandhu, in erecting *Neocorynothrips*, did not publish a description of the genus, but only very briefly pointed out its affinities to known genera. Further, an examination of the type specimen of the genotype reveals many inaccuracies in this. The genus is therefore, described for the first time and the type species is redescribed from the holotype specimen.

Body devoid of net-sculpturing or silky down. Head longer than broad at base, where it is widest; distinctly produced into an anteriorly narrowing four-tipped process in front of and between the eyes. Antennae distinctly 8-segmented, style 2-segmented, distinctly shorter than the 6th antennal segment; the 3rd and 4th segments bear forked sense-cones. Mouth-cone broadly rounded, reaching well beyond the middle of prosternum; maxillary palpi 3-segmented. Prothorax with only one bristle of moderate length at each hind angle. Fore wings with two longitudinal veins.

The prominent cephalic process suggests affinity to *Corynothrips* Williams* and this probably led the protologists to place it in the subfamily Corynothripinae Karny, 1921. But, the clearly 8-segmented antenna and the two longitudinal veins in each forewing unequivocally remove this genus from Corynothripinae to Chirothripinae Of the two Chirothripine genera (*Chirothips* Halid. and *Limothrips* Halid.) it is very closely allied to the section of *Limothrips* Haliday having forked trichomes on 3rd and 4th antennal segments, but differs from them in having only one seta at each hind angle of prothorax, and, the setae at the end of the abdomen not as strongly developed as in *Limothrips*.

Genotype *Neocorynothrips asiaticus* Ramk. & Marg.

Neocorynothrips asiaticus Ramk. & Marg.

1939. *Neocorynothrips*, *asiaticus*, Ramakrishna & Margabandhu, *Rec. Ind. Mus.*, **41** (4) : 22,23.

Holotype female redescribed.

General colour yellowish-brown masked by deep pink hypodermal coagulations; fuscous in about the last three abdominal segments and in the mid-and

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* *J. econ. Biol.*, **8** (4) : 207, 208 (1913).

hind tibiae. Fore tibiae yellow, margined with blackish-brown. All tarsi and antennal segments 3-8 yellow; the 5th and 6th segments near the tip and the stylar segments grey-infumate. Maxillary palpi very narrowly black-margined. Tarsi with an ovoid black patch on the plantar surface. Eyes black with madderbrown margins; ocelli with red pigment cups. Fore wings uniformly light fuscous; hind wing with a darker stripe running in the middle from the base to near the apex. Femora concolorous with the body.

Head longer than broad at base, produced into a four tipped projection between and in front of the eyes; the process about half as long as broad at base. On this process, distally, the antennae are placed quite close together so that a narrow bifid process of the head projects forward between their bases. A distinct row of about eight setae runs from near the base of each antenna over the frons quite close to the inner margin of the respective eye, diverging from each other posterior-wards. Eyes large, projecting, about 0·45 as long as the head; the space between them dorsally is approximately equal to the diameter of each eye. The posterior ocelli just in front of a line drawn through the hind margin of the eyes, and the median ocellus across the middle of the eyes; the three ocelli almost equidistant from one another. Cheeks crenulate with a deep constriction behind the eyes, succeeded by an angular protuberance, followed again by a wide shallow cavity; on the post-ocular bulging are two short curved setae one behind the other; the width across these angular swellings is about the same as at the base of the head. Mouth-cone broadly rounded, reaching well beyond the middle of prosternum. Maxillary palpi 3-segmented, short, not attaining the tip of the mouth-cone; the basal and apical segments sub-equal and the middle one the shortest, basal the broadest, 2nd narrower and the apical the thinnest, rounded at tip and provided with 3 or 4 minute bristles. Labial palpi stumpy, single-segmented, papilliform, widely separated from each other. Antennae with the basal two segments barrel-shaped, concolorous with the head and provided with dark spines; segments 3-5 elongate-fusiform, with a ring of long, slender, light brown spines at about their distal third; 6th segment of almost even width in the basal two-thirds (the yellowish part), thenceforth gradually tapering; inconspicuous, thin hyaline, long spines in the distal half; 7th broadly united with the 6th behind and 8th in front, gradually tapering forward; the 8th tapering almost to a point—the distal third of the 6th segment and the two stylar segments together forming a thin cone. Antennal segments 3 and 4 provided with forked trichomes; those of the 4th are thin, long and symmetrically branched as usual, while those of the 3rd have one arm short and curved and the other long and almost straight, like those on the 3rd segment of the antennae of *Limothrips angulicornis* Jablonowski.* Antennal segments 5 and 6 bear one simple sense-cone each.

Prothorax broader than long, narrowed in front, sides arched, anterior angles very finely crenulate with a short, forwardly directed spine; each posterior angle with only one curved seta of moderate length.

Pterothorax broad in front, narrowed behind; at its broadest about as wide as long, sides rounded, slightly constricted between the meso and meta thorax.

Legs. The fore legs short, mid and hind legs longer. All legs with small spines strewn on their surface; the front and mid tibiae bear a moderately long spine at the tip on the inner side; the hind tibiae with a comb of long spines on about the distal two-thirds of the inner margin.

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* Vide Priesner: *Die Thysanopteren Europas*, p. 145 (1928).

Wings extend to about the 8th abdominal segment, elongate. The front pair with two longitudinal veins; their surface strewn closely with brownish microchætae; costa with 18 setae, upper vein with 3 near the base and 2 near the tip, lower vein with 13 setae more or less uniformly spaced between the two groups of setæ on the upper vein.

Abdomen elongate about as broad as mesothorax. Segment 9 unusally long and tapering; provided with three pairs of lateral long spines and one pair of thinner ones; dorsally one pair of thin, short spines. The 10th segment sharply conical, with a dorsal longitudinal slit. Ovipositor slender, elongate, not protruding beyond the tip of the abdomen; a circlet of six, long setae nearly 2/5 from the tip of the 10th abdominal segment.

Measurements of the holotype female:

Entire length of body 1·283 mm.

	Length	Breadth
Head	0·143 mm.	0·121 mm.
Prothorax	0·131 mm.	0·186 mm.
Pterothorax	0·261 mm.	0·243 mm.
Abdomen	0·750 mm.	0·243 mm.
9th abdominal segment	0·143 mm.	
10th abdominal segment	0·107 mm.	

Antennal segements	III	IV	V	VI	VII	VIII
Length (μ)	69	69	53	76	17	20
Breadth (μ)	20	20	17	17	10	7

Ramakrishnothrips, gen. nov.

Two species *Taeniothrips jonnaphila* Ramk[1] and *T. cardamomi* Ramk[2]. differ from the rest of the *Taeniothrips* Amyot & Servillé in having a distinct, four-tipped process in front of and between the eyes, the antennae being inserted near the tip of this process. This character, among others, removes these two species from Thripinae Karny and automatically from the genus *Taeniothrips* to the Chirothripinae Karny. As these two species are very closely allied to each other, but cannot justifiably be placed in any of the known genera of Chirothripinae, a new genus is being proposed for their reception. It is named *Ramakrishnothrips* and characterised as follows:—

Body without net-sculpture or silky down. Head about as long as broad or slightly longer, broadening towards the base; vertex produced in front of the eyes into a four-tipped prominence which bears the antennae near its tip. Mouth-cone long, broadly rounded, reaching beyond the middle of prosternum. Antennae about twice as long as head, 8-segmented, style 2-segmented and shorter than the 6th antennal segment; sense-cones on 3rd and

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(1) *Mem. Dept. Agr. Ind., ent. Ser.*, (7) **10**: 256-258 (1928).

(2) *Bull. ent. Res.*, **26** (3): 357-358 (1935).

4th segments forked. Maxillary palpi 3-segmented. Pronotum about as long as head, broadly oval, with two slender, long, hyaline setae at each hind angle, other setae small and inconspicuous except those at the tip of abdomen. Wings almost unicolorous, slightly paler basad, well-developed and provided with long slender setae concolorous with the lamina.

This genus differs from *Neocorynothrips* (Ramk. & Marg.) Shumsher, its closest ally, in having two long post-angular prothoracic setae instead of one of moderate length.

The author has great pleasure in naming this new genus after Dr. T. V. Ramakrishna Ayyar, the pioneer Indian Thysanopterist.

Genotype *Ramakrishnothrips* (=*Taeniothrips*) *jonnaphila* (Ramk.)

Ramakrishnothrips jonnaphila (Ramk.)

1928. *Taeniothrips jonnaphila*, Ramakrishna, *Mem Dep. Agr. Ind., Ent. Ser.* (7), **10**: 256-258.

The following is a supplement to the original description of the species:—The cephalic process in front of and between the eyes is 1/6 as long as the entire length of head. Behind each eye are 3-5 setae of almost equal length. Sides of pronotum almost parallel, very lightly arched, hind margin alone strongly arched. The inner postero-angular prothoracic setae about 1/3 longer than the outer. Pterothorax about as long as broad. Costa of fore wing with 24-28 setae, upper vein with (3+7)+2, lower vein with 13-14.

Hitherto known to occur on maize, *jowar* (*Andropogon sorghum*) and sugarcane; now recorded on flowers of *sarson* and leaf-sheaths of grass at Delhi.

Pruthiella, gen. nov.

Haliday's description of *Limothrips* (1836) makes no mention of the nature of sense-cones on the 3rd and 4th antennal segments, and subsequent descriptions are also silent about it. The typical species, *Limothrips cerealium* Halid. and *L. denticornis* Halid., however, possess simple sense-cones. Therefore simple sense-cones on the 3rd and 4th antennal segments should be considered as a character of *Limothrips* Haliday.

Inclusion of species with simple and those with forked sense-cones in one genus, whatever else their resemblances, would warrant the amalgamation even of well established genera like *Bregmatothrips* Hood and *Taeniothrips* Am. & Serv. The structure of the sense-cones on these two antennal segments merits generic value.

Limothrips angulicornis Jablonowski (1895), *L. schmutzi* Priesner (1919) and probably also *L. consimilis* Priesner (1928)[1] which have forked trichomes on the 3rd and 4th antennal segments are, therefore, placed under a new genus, for which I propose the name *Pruthiella* in honour of Dr. Hem Singh Pruthi, Imperial Entomologist to the Government of India.

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(1) For descriptions of the three species see Priesner: *Die Thysanopteren Europas*, pp. 145, 146; 149, 150. (1928).

Head almost as broad as long or somewhat longer, somewhat narrowed in front, anteriorly produced between the eyes though very slightly. Antennae 8-segmented, borne on the cephalic projection, sense-cones on the 3rd and 4th segments forked, one of the branches curved and the other straight. Maxillary palpi 2-segmented. Prothorax somewhat shorter than head; a single long seta at each prothoracic hind angle Setae on 9th abdominal segment very long and stout. Males wingless and without ocelli Wing spines in females small and few. Legs unarmed, powerful, particularly the front pair.

This genus differs from *Limothrips* Haliday in having paired sense cones on the 3rd and 4th antennal segments, in its head being produced in front of the eyes only a little as compared to the latter genus, and the eyes much less protruding. From *Oxythrips* Uzel, s.str., it is distinguished by having 2-segmented maxillary palpi; and from *Neocorynothrips* (Ramk. & Marga.) Shumsher in this respect and in having a shorter head process, though the shape of the forked sense-cones in *Pruthiella* resembles very closely that of the type species of *Neocorynothrips.*

Genotype *Pruthiella* (=*Limothrips*) *angulicornis* (Jablonowski).

Neolimothrips, gen. nov.

Body elongate, slender, with neither net-sculpture nor silky down. Head about as long as broad or longer, of uniform width behind the eyes, produced into a four-tipped process in front of and between the eyes, antennae borne nearly at the tip of this process. Ocelli and wings present in females, absent in males. Antennae short, 8-segmented, with simple sense-cones; style shorter than the 6th antennal segment. Mouth-cone narrow, long, almost reaching hind margin of prosternum; maxillary palpi long, slender, 2-segmented. Prothorax a little longer than the head, somewhat broadened behind, hind angles provided with two long slender setae each. Legs normal, unarmed. Front wings (of females) with two longitudinal veins. Tip of abdomen in female conical with long setae.

This genus very closely resembles *Limothrips* Haliday, but differs from it in having two post-angular prothoracic setae instead of one, in having the head shorter than the prothorax and in the female having a conical rather than tubular tip of abdomen. From *Bregmatothrips* Hood it differs in the maxillary palpi being 2-segmented instead of 3-segmented, and in having the four-tipped antenniferous cephalic process.

Genotype *Neolimothrips brachycephalus,* sp. nov.

Neolimothrips brachycephalus, sp. nov.

Female.—General body color yellowish-brown, head and abdomen darker. Legs light yellow with the outer margin of all femora broadly dark, the outer margin of fore tibiae narrowly margined, black; outer and inner margins of mid-and hind tibiae dark in their basal halves, a dark oval patch on ventral surface of the 2nd tarsal segments. All body setae hyaline yellow. Wings pale yellow. Ocelli orange-yellow with irregularly shaped maroon "cups". Eyes black. The basal two and distal three antennal segments concolorous with head, the rest light yellow.

Head about as long as broad, projecting (about 1/5 its length) in front of the eyes. Dorsal interocular space about 1·6 times the width across an eye. Hind ocelli larger than the front ocellus, all three equidistant. The hind ocelli lying across near the middle of the length of the head, and very close to the inner margin of the eyes, the front ocellus about a third of the head-length from the front margin of the head. Eyes nearly as long as the cheeks behind, reniform, neither projecting nor prominent. Interocellar setae thin and long, one in front of each hind ocellus. A pair of setae near the base of antennae, another pair near the anterior margin of eyes A pair of thin long setae as much behind the hind ocelli as the interocellars are in front; three smaller setae in a curve behind the eye, parallel to its hind margin, one very small spine post-ocular. Cheeks parallel, finely crenulate, glabrous. Occiput very finely cross-striate. Ventrally, there are two small bristles near the base of antennae, and one near the front margin of each eye; one internal to the middle of inner margin of each eye, three near the hind margin of the frons and a few very small ones strewn here and there. Mouth-cone long, narrow, nearly reaching the hind margin of prosternum, constricted in the middle, where a pair of slender, 2-segmented maxillary palpi arise. First palpal segment shorter, the 2nd at base about as broad as the 1st, gradually tapering to the tip. Antennae short, slender, 8 segmented with simple sense-cones. 1st segment short, broad, cylindrical; 2nd barrel-shaped; 3rd elongate, cup-shaped with a basal style; 4th and 5th oval; 6th elongate oval, tapering distally; stylar segments thin, tapering towards the tip.

Prothorax trapezoidal, with hind margin slightly convex, in front about as broad as head, slightly widening towards base, broader than long; one very short forwardly curved seta at each front angle; two long ,slender setae at each hind angle, one tiny inter-post-angular and three post-marginals, of which the inner-most is longest, on each side; the lateral margin and dorsal surface with a few small, scattered setae

Pterothorax resembling that of *Ramakrishnothrips jonnaphila* (Ramk.).

Legs well developed, the front and hind pairs slightly longer than the middle pair; a few long, slender setae irregularly strewn on surface. Hind pair of tibiae with a regular row of about four long setae on the inner margin in the distal third and two thicker spines at tip.

Wings well developed, with two longitudinal veins in each fore wing. Fringes well developed. Costa with 22 long spines, upper vein with 4 near the base and 2 near the tip, lower vein with 8 spines in a continuous row.

Abdomen broadening towards the middle, where it is about as broad as pterothorax and tapering to the tip. Ovipositor well developed, reddish-brown. The 8th abdominal segment without a fringe. Long, slender setae intermixed with smaller, slenderer ones on 9th and 10th segments.

Measurements of holotype female :—

Total body length nearly 1·2 mm.

	Length	Breadth
Head	0·136 mm.	0·136 mm.
Interocular dorsal space ..		0·064 mm.

	Length	Breadth
Cephalic projection	0·028 mm.	
Prothorax	0·140 mm.	0.188 mm.
Pterothorax	0·260 mm.	0·240 mm.
Wing (without fringes) ..	0·780 mm.	

Antennal segments	I	II	III	IV	V	VI	VII	VIII
Length in μ	12	32	38	28	32	48	12	12
Breadth in μ	28	25	17	16	18	18	6	4

Male.—Similar to female, but apterous and without ocelli. Head and apical half of abdomen dark brown, rest of the body pale yellowish-brown. Head longer than wide. Tip of abdomen roundly conical; penis pyriform, brown No specially stout, short setae on 9th and/or 10th abdominal segments.

Measurements :—

Total body length nearly 1·0 mm.

	Length	Breadth
Head	0·124 mm.	0·116 mm.
Interocular dorsal space ..		0·052 mm.
Cephalic projection	0·024 mm.	
Prothorax	0·128 mm.	0·160 mm.
Pterothorax	0·190 mm.	0·192 mm.

Described from one female and two damaged males collected from ears of *bajra* (*Pennisetum typhoideum*) in Ambala Cantonment on 6-x-1940 (S. No. 42).

Types in the Imperial Pusa Collection, I. A. R I., New Delhi

SERICOTHRIPINAE Karny, 1921[1]

Dendrothripiella Bagnall, 1927

Subgenus **Projectothripoides**, nov.

Body without net-sculpture, silky hair or long setae; broad and flat. Head short, very broad; hollowed in front between the eyes. Ocelli close to each other just behind the depression, widely separated from the eyes. Each eye about a quarter as broad as the head. Antennae 7-segmented, style 1-segmented, much shorter than the 6th segment, forked sense-cones on 3rd and 4th segments nearly at their tips, the style and the two preceding segments broadly united to form an elongate compact cone. Mouthcone reaching beyond the middle of prosternum; maxillary palpi 3-segmented. Pronotum more than twice as long as head, transverse, ovate; 2 short setae at each hind angle and one very short seta at each front angle. Wings well developed, front pair with two

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(1) Karny has characterised this subfamily as "having the body extremely broad and thick-set, when not so the fore wing has only one longitudinal vein". There is no connecting link between the two alternative characters given. The present author intends dealing with the classification of Thysanoptera in a separate paper, where he will try to elucidate anomalies of this nature. For the present he follows Karny's classification *Treubia*, I. (4) (1921) as modified by Priesner in *Die Thysanopteren Europas* (1928).

longitudinal veins, the upper vein with an interrupted row of setae. Abdominal tergites 7 and 8 with a complete comb of close and fine fringes on their hind border, tergites 1-6 with the fringe wanting only in the middle third of each segment.

This subgenus differs from Bagnall's *Dendrothripiella*, s. str. in that the hind borders of its abdominal tergites 1-8 bear a more or less complete ciliary fringe. In this respect it agrees with *Projectothrips* Moulton, but differs from it in having 7-segmented antennae, without the peculiar dorsal lobes on the 2nd antennal segments. The possession of the ciliary fringes alone does not warrant erection of a new genus; in view of the many similarities, therefore it is best kept as a subgenus of *Dendrothripiella* Bagnall.

Type of subgenus *Dendrothripiella* (*Projectothripoides*) *pandai*, sp. nov.

Only females have yet been found. Finding of males may probably shed more light on the systematic postion and status of this subgenus.

Dendrothripiella (Projectothripoides) pandai, sp. nov.

Female.—General color pale yellow. Ocelli orange with red pigment cups. Eyes dark maroon in reflected light, black by transmitted light. Antennae very pale yellow, except the distal 2/3 of the 6th and entire 7th segments which are grey. The tip of the mouth-cone and the ventral surface of the 2nd tarsal segments blackish-brown. Margins between the abdominal segments 3-7 narrowly brown. Ovipositor brownish-yellow.

Head much broader than long, fore margin almost straight, with a small sharp median depression. Cheeks roundly converging behind. Eyes projecting, though small, reniform, each longer than cheeks and about a quarter as wide as head. Occiput finely cross-striate. Ocelli close to one another in an obtuse-angled triangle, front ocellus as far removed from the front margin of head as the hind ones are from the inner margins of eyes. Head, in front of the ocelli and between the eyes, depressed. Eyes sparsely pilose. Base of the mouth-cone much broader than its length, yet the mouth-cone almost reaches the hind margin of prosternum. Maxillary palpi 3-segmented, the middle segment the shortest. Antenna 7-segmented, arising from pits in front of the head, separated from each other at base by a slightly shorter distance than the width of the basal antennal segments. A little mesad to the base of antennae the front of the head bears a pair of stumpy papillae. (The antennae in both the type specimens are probably slightly telescoped.) The 1st antennal segment of the shape of a deep finger-bowl, sunk in the frontal cavity; 2nd cup-shaped, rounded distad; 3rd similar in shape but provided with a thin basal style; 4th of the shape of an abbreviated vase; 5th elongate-cup-shaped, broadly united to the 6th which is of the shape of a round-bottomed bottle; the 7th broadly united with the "neck of the bottle", tapering distad. The 3rd and 4th segments with short, stout, forked sense-cones near their tips.

Pronotum ovoid, transverse, with one tiny forwardly directed spine at each front angle and two short postero-exteriorly directed setae at each hind angle. Surface finely cross-striated and irregularly strewn with microchaetae.

Pterothorax about as long as broad, squarish, sides slightly constricted in the middle.

Legs normal, sub-equal in length and thickness.

Wings very light yellowish-grey, with a greyish fringe. Front margin arched at tip to meet the almost straight hind margin. Costa with 28-30 spines, upper vein with (6+3)+1+1+1, and lower vein with 4 widely spaced spines. All wing-spines short, only about half as long as the width of the wing. Posterior fringe much more developed than that on the front margin, which (latter) starts from basal third or so.

Abdomen about as broad as the pterothorax, spindle-shaped but flattened. Hind borders of abdominal tergites 1-8 provided with a close fringe of fine cilia, that on segments 7 and 8 complete, on the remaining segments missing in the middle third or so. Terminal abdominal setae slender and small.

Measurements:

Total length of body 0.7 mm.

	Length	Breadth
Head	0.068 mm.	0.136 mm.
Interocular dorsal space		0.060 mm.
Eyes	0 040 mm.	0.036 mm.
Antenna	0.180 mm.	
Pronotum	0.156 mm.	0.172 mm.
Pterothorax	0.190 mm.	0 200 mm.
Abdomen		0.210 mm.

Antennal segments	II	III	IV	V	VI	VII
Length in μ	32	32	28	32	36	30
Breadth in μ	24	20	18	16	14	6

Described from two females taken on leaves of *Ficus religiosa* at Cuttack (Orissa), on 11. vi. 1941 (S. No. 115).

Named after its discoverer, Mr A. R. Panda, a fellow student at the Imperial Agricultural Research Institute, New Delhi.

Types in the Imperial Pusa Collection, I. A. R. I., New Delhi.

The dark margins between the abdominal segments 3-7 and the general coloration lends resemblance to *Anaphothrips oligochaetus* Karny, but the 7-segmented antennae and the peculiar *Projectothrips*-like ciliary fringe of abdominal segments 1-8 distinguish this species from *A. oligochaetus* and from all others known to the author.

Anaphothrips Uzel

1895. *Anaphothrips*,. Uzel. *Monogr. Ord. Thysan*, p. 142.
1913. *Neophysopus*, Schmutz. *Sitzbr. Akad. wiss. Wien.*, **122** : 1016. (new synonym)
1914. *Euthrips*. Karny. *Zeit. wiss. Insektenbiol.* **10** : 355.
1921. *Anaphothrips*. Karny. *Treubia* **1** : 242.
1928. *Anaphothrips*, Priesner, *Die Thysan. Europas*, p. 181.

This genus was erected by Uzel with *Anaphothrips ferruginea* Uzel, possessing clearly 8-segmented antennae and having no noticeable setae at hind angles of pronotum, as type species. Karny (1921) and Priesner (1928), in dividing the genus into subgenera have given the name subgenus *Anaphothrips*, s. str. to the group comprising *A. obscurus* (Müller) 1776, *A. badius* Williams 1913, and *A. secticornis* (Trybom) 1896, all three of which possess apparently 9-segmented antennae due to a false partition of the 6th segment. They have placed under the subgenus *Neophysopus* Schm. the type species and most of the other species which Uzel described as *Anaphothrips* in his monograph.

In accordance with Article 9 of the International Rules of Zoological Nomenclature, "If a genus is divided into subgenera, the name of the typical subgenus must be the same as the genus", *i.e*, the genotype, and so far as possible the bulk of species belonging to the genus must be included in the subgenus which bears the name of the genus. Therefore, the species at present under the subgenus *Neophysopus* Schmutz, must be placed under *Anaphothrips*, s. str. and *Neophysopus* be sunk as a synonym. For the subgenus containing *A. obscurus*, *secticornis* and *badius*, now left without a name due to *Anaphothrips* becoming the type subgenus, the author herewith proposes the name *Pseudoarticulella* in conformity with the fact that it possesses apparently 9-segmented antennae due to the oblique, false partition of the 6th segment.

According to the Law of Priority, the type of the newly named subgenus is *Anaphothrips* (*Pseudoarticulella*) *obscurus* (Müller)[1], by present designation.)

In 1925 Priesner[2] erected the subgenus *Hemianaphothrips*, with *A.* (*H.*) *articulosus* Pr. as type species, having distinctly 9-segmented antennae. But for the border-line cases like *Pseudoarticulella* Shumsher with apparently 9-segmented antennae, it would have been difficult to include the subgenus *Hemianaphothrips* in *Anaphothrips* Uzel, predominantly composed of species with 8-segmented antennae.

The subgenus *Chaetanaphothrips*, erected by Priesner probably in 1928 is characterised by him as having 8-segmented antennae, well developed, banded wings and long setae at hind angles of prothorax. *Euthrips orchidii* Moulton (1907) is the type species. This subgenus has interesting resemblances to the genus *Taeniothrips* Am. & Serv.

Dantabahuthrips, subgen. nov. with a tooth on the inside near the tip of the fore tibiae and another but blunt one near the base of the fore femora, due to numerous similarities would come under the genus *Anaphothrips* Uzel.

Key to the Subgenera of ANAPHOTHRIPS *Uzel.*

1. Antenna distinctly 9-segmented style 3-segmented............*Hemianaphothrips* Priesner.

Antenna apparently 9-segmented due to false partitioning of the 6th segment...*Pseudoarticulella* Shumsher, nom. nov.

Antenna clearly 8-segmented..

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[1] Full synonymy of this species will be found in Priesner, *Die Thysanopteren Europas*. pp. 183-185 (1928).

[2] Priesner, *Zeit. öst. ent. Ver.* **10**, vide Priesner, *Die Taysanopteren Europas*, p. 709 (1928).

2. Fore-tibiae with a tooth at the tip on the inside. more developed in the male. less in the female..*Dantabahuthrips* Shumsher. subgen. nov

Fore tibiae unarmed 3

3. Prothoracic hind angles with well developed setae .. *Chaetanaphothrips* Priesner.

Prothoracic hind angles without noticeable setae .. ... *Anaphothrips. Uzel* s. str.

Anaphothrips (Hemianaphothrips) palmae Ramk.

1934. *Hemianaphothrips, palmae,* RAMAKRISHNA, *Rec. Ind. Mus.* 36, (4): 491, 492.

The following is a supplement to the original description of this species:

Cheeks with a tiny postocular spine and a few other minute ones a little behind, arising in between the crenations. Maxillary palpi 3-segmented; basal joint the broadest and longest, the other two segments subequal in length, the last the narrower, rounded at tip and provided with 3 or 4 setae; the basal segment slightly narrower towards the base. Labial palpi a little longer than the 3rd maxillary palpal segment, but thinner.

Wing chaetotaxy: Costa with about 40 setae, upper vein with (5+5)+1+1+1 or (4+4)+1+1+1, and lower vein with 12 setae.

Antennal segments	II	III	IV	V	VI	VII	VIII	IX
Length in µ	36	57	52	52	57	12	12	21
Breadth in µ	25	20	20	18	18	10		

The 3rd segment is erroneously described as 70 µ long in the original description.

This species very closely resembles *Hemianaphothrips articulosus* Pr. forma *macroptera*[1] but is slightly larger (1·36 mm.: 1·08 mm.); *articulosus* Pr. has only 8 or 9 setae on the lower vein, and the wings in *articulosus* Pr. are grey throughout, while in *palmae* Ramk. there is a light basal patch.

Dantabahuthrips[2] subgen. nov.

Body devoid of net-sculpture, silky hair and conspicuous, long setae. Cheeks parallel sided. Antennae 8-segmented, style 2-segmented, shorter than the 6th segment. Antennal segments 3 and 4 with forked sense-cones. Maxillary palpi 3-segmented. Fore wing with two longitudinal veins sparsely beset with moderately long, slender, inconspicuous setae. Fore legs strongly thickened; fore tibia armed with a tooth at tip on the inside—less developed in female, well developed in male; fore femora armed with a blunt tooth internally basad; fore tarsi unarmed.

Resembles *Odontothrips* Am. & Serv. in having the fore tibiae armed distally, and in many other respects, but differs in having the fore tarsi unarmed,

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(1) Priesner, *Die Thysanopteren Europas*. p. 709 (1928).

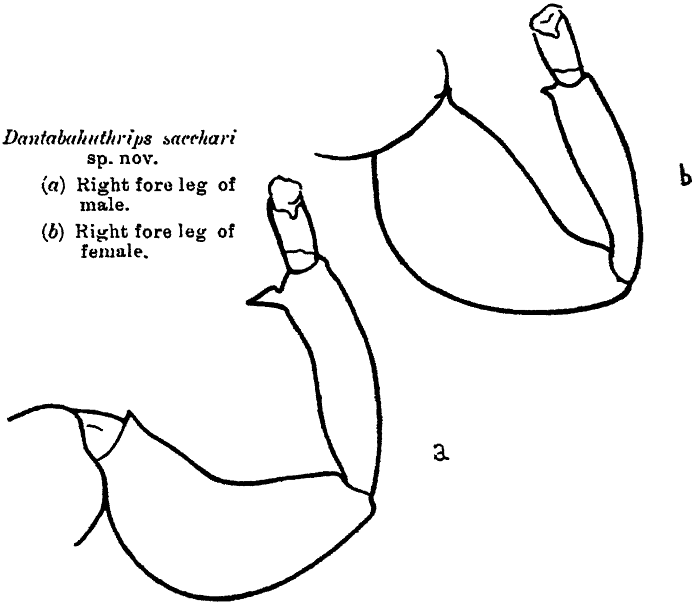
(2) From Sanskrit *Danta*=tooth and *Bahu*=arm.

the setae on the body inconspicuous, weak and short, and in the wing-veins being sparsely provided with setae. Its relation to the other subgenera of *Anaphothrips* Uzel, s. lat. has already been dealt with on pages 123-124.

Type of subgenus *Anaphothrips*-(*Dantabahuthrips*) *sacchari*, sp. nov.

Anaphothrips (Dantabahuthrips) sacchari, sp. nov.

Macropterous female.—General color pale yellowish-brown, thorax slightly darker; antennal segments 1-5 and basal quarter of 6 concolorous with head, the remaining antenna fuscous-grey. The tip of mouth-cone and that of the abdomen blackish-brown. A dark grey spot under each 2nd tarsal segment Eyes black; ocelli with red pigment cups. Wings pale yellow, with very faint grey infumation. Body surface devoid of any sculpturing or silky down.



Dantabahuthrips sacchari sp. nov.
(*a*) Right fore leg of male.
(*b*) Right fore leg of female.

Head broader than long, vertex broadly rounded in front. Cheeks parallel Eyes conspicuous, but neither bulging nor pilose; dorsally the space between them is about 1·5 times the diameter of each. Just behind the eyes is a small but sharp constriction, behind which stands a forwardly curved, transparent, short post-ocular seta. Ocelli arranged in an equilateral triangle, the hind pair separated from the margin of the eyes by their own diameter and removed from the base of the head as much as the front ocellus is from the front margin. Mouth-cone rounded at tip, nearly reaching the middle of prosternum. Maxillary palpi 3-segmented, slender, long; 2nd segment the shortest, the apical and basal subequal in length; their width diminishing from base to apex. Antennae 8-segmented, style 2-segmented. Length of antenna nearly equal to the length of pterothorax. 1st segment cylindrical, short and broad, 2nd cup-shaped with a thick basal stem and truncated at tip. 3rd with a thin basal style gradually widening upto about the distal quarter, thence abruptly tapering, 4th and 5th segments oval 6th rounded at base, gradually tapering from basal third towards the tip, stylar segments narrow, gradually narrowing distally. Segments 3 and 4 with small, forked sense-cones.

Prothorax broader and longer than head, almost rectangular, with sides weakly arched slightly widened behind. Only one conspicuous seta of moderate length at each hind angle and a few tiny post-marginal pronotal setae. A little behind each coxal cavity the prosternum bears one, more or less pointed, stumpy tooth: the pair being connected at base by a forwardly arched suture.

Pterothorax broader than prothorax, about as long as broad, and of almost uniform width, only slighthly narrower behind.

Legs: Fore and mid legs spineless. Fore femora incrassate (Text fig. b), with a small blunt triangular tooth on the inside at base. Fore tibiae with a minute tooth on the inside at tip; fore tarsi unarmed. Fore and mid tibiae almost equally thickened; hind legs slender, longer than the front two pairs. The hind tibiae with a comb of spines in the distal 2/3 on the inside, the length of the spines increasing towards the tip of the tibia. Hind tarsi with similar but smaller, two or three spines internally.

Wings reach the 7th abdominal segment. Fringes long and wavy. Costal spines and those on the veins inconspicuous, weak. Hind wing with a brown streak which stops short of the tip of the wing. Each fore wing with two longitudinal veins; the upper vein with two widely separated bristles in distal third, the terminal bristle of lower vein stands between them. (Unfortunately the wings are so crumpled as to allow of no satisfactory account of wing chaetotaxy being given.)

Abdomen elongate, almost uniformly broad upto about the 7th segment, about as broad as the pterothorax thence gradually tapering to the tip, the base of this cone rounded. Terminal abdominal setae pointed, hyaline, long and slender, those on the 9th segment about as long as the 10th segment and those on the 10th segment slightly shorter.

Measurements:

Total body length 1·22 mm.

	Length	Width
Head	0·088 mm.	0·117 mm.
Prothorax	0·143 mm.	0·165 mm.
Pterothorax	0·220 mm.	0·220 mm.
Antenna	0·220 mm.[1])	

Antennal segments	I	II	III	IV	V	VI	VII	VIII
Length in μ	18	36	36	36	36	40	7	11
Breadth in μ	26	22	16	16	16	14	5	3

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(1) The total length of antenna may be a little different from the sum of the lengths of individual segments, depending upon whether the segments are telescoped or the inter-segmental membrane is unduly stretched.

Macropterous male. Similar to female, but antenna like the rest of the body pale yellowish-brown as also the tip of the abdomen Testes pyriform, conspicuously reddish-yellow, lying in the 7th abdominal segment; penis concolorous with the body.

Fore femora (Text fig. a) arched, such that the inner margin is concave in the middle; a blunt tooth at the base of this margin. Fore tibiae narrow at base, gradually widening to end of basal third, then bodily curved with convex margin outwards, almost uniformly wide in the distal 2/3. A sharp, large, erect tooth at tip on the inside. The tooth with a slight constriction near its base on the side facing the tarsi.

Measurements:[1]

Total body length approximately 1·0 mm.

Length of head .. .. .. 0·081 mm.
,, ,, prothorax .. .. .. 0·143 mm.
,, ,, pterothorax .. .. .. 0·202 mm.
,, ,, antenna .. .. .. 0·202 mm.

Antennal segments	I	II	III	IV	V	VI	VII	VIII
Length in μ	20	29	35	33	33	37	7	11
Breadth in μ	27	23	16	16	16	15	5	3

Described from one female and one male collected by the author from sugarcane leaf-sheaths at Rupar (Punjab) (S. No. 56).

The female of this species very closely resembles that of *Anaphothrips ramakrishnae* Karny, but the armed fore femora and tibiae (more conspicuously those of the male) are significant.

Types in the Imperial Pusa Collection, I. A. R. I., New Delhi.

Anaphothrips flavicinctus (Karny)

1912. *Euthrips flavicinctus*, Karny, *Marcellia*, **11** . 115.
1913. *Neophysopus medioflavus*, Schmutz. *Sitzber Akad. Wiss. Wien*, **122** : 1017.
1919. *Euthrips citricinctus*, Bagnall, *A. M. N. H.* (9). **4** : 270.
1925. *Anaphothrips flavicinctus*, Karny, *Ark. Zool.*, **17** : 17.
1928. *Anaphothrips (Euthrips) citricinctus*, Ramakrishna. *Mem. Dept Agr. Ind.*, *ent. Ser.*, (7) **10** : 269.

In 1925 Karny synonynised *Neophysopus medioflavus* Schmutz, with his own *Anaphothrips (Euthrips) flavicinctus* In 1928 Ramakrishna suggested that *Anaphothrips (Euthrips) citricinctus* (Bagnall) was probably a synonym of *A. flavicinctus* (Karny). In 1940 in collaboration with Margabandhu he however maintained *A. citricinctus* (Bagn.) is a species distinct from *A. flavicinctus* (Ka.), and made *Neophysopus medioflavus* Schm. synonymous with the latter.[2] Thus there is a good deal of confusion with regard to the synonymy of these three species

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(1) It has not been possible to give the breadth of the head. pro and pterothorax in the case of the male because the unique allotype is laterally mounted.

(2) Ramk. & Marga., *Cat. Ind. Ins.*, **25** : 8 (1940.)

A comparison of the original descriptions of *N. medioflavus* and *Eu. flavicinctus* shows the following apparent differences between them :

In *flavicinctus* the mouth-cone reaches the hind margin of the prosternum, the 2nd antennal segment is much shorter than the 3rd and the wings reach the 8th abdominal segment, while in *medioflavus* the mouth cone reaches only about the middle of prosternum, the 2nd antennal segment is as long as the 3rd and the wings reach the 6th abdominal segment.

Among the twenty odd specimens collected in North India on maize, sorghum, sugarcane and grasses most of them combine two characters *viz.*, mouth-cone reaching hind margin of prosternum and the 2nd antennal segment being as long as the 3rd. The lengths of mouth-cones imperceptibly ranged between that characteristic of *flavicinctus* and *medioflavus*. In a few specimens with distended abdomen, the wings reached to about the 6th abdominal segment, while in other specimens, the 8th.

The present author therefore agrees with Ramakrishna and Margabandhu and with Karny in relegating *medioflavus* Schm. as a synonym of *flavicinctus* (Ka.)

Further, according to Bagnall, his *Euthrips citricinctus* differs from *flavicinctus* of Karny in having the legs differently colored, antennae shorter and head differently shaped in front.

The lengths of antennal segments 1-3 of *citricinctus* have not been given by Bagnall, most probably due to their irregular orientation. The lengths of segments 4-8 agree with those of the corresponding segments of *flavicinctus* Ka. The irregular orientation of the three basal joints in the types of *citricinctus* Bagn. is the most likely reasons for the apparent shortness of the antenna. Among the specimens studied by the present author, the color of the legs also vary slightly.

Hence the author considers *Euthrips citricinctus* Bagnall also to be a synonym of *Anaphothrips flavicinctus* (Karny).

Hitherto known to occur on leaves of arrow-root and shoots of sorghum and *Pennisetum typhoideum* in South India, and now noted on leaf-sheaths of sugarcane, on leaves of *Raphanus sativus*, wheat and paddy, on leaf-sheaths and cobs of maize and on flowers of tobacco and *Lawsonia inermis* (*L. alba?*) in North Indian plains.

Anaphothrips hemavarna (Ramk.)

1931. *Oxythrips hemavarna*, RAMAKRISHNA. *J Bombay nat. Hist. Soc*, **34** (4): 1036

Uzel (1895) included in his genus *Oxythrips* species with one or two long setae at each hind angle of pronotum, but in 1921 Karny rightly restricted this genus to species with only one post-angular prothoracic seta and removed the rest, with two post-angular prothoracic setae, to *Taeniothrips* Am. *et* Serv.

Oxythrips hemavarna Ramk. possesses two short, faint, transparent bristles at each postero-lateral prothoracic angle ; it also possesses only short, slender setae on the veins of the wings and very small interocellar setae. All these characters place ***hemavarna*** Ramk. in the genus *Anaphothrips* Uzel very close to *oligochaetus* Karny and *ramakrishnae* Karny, most probably in the subgenus *Chaetanaphothrips* Priesner.

THRIPINAE Karny, 1921

Frankliniella intonsa (Trybom)

1895. *Thrips intonsa*, TRYBOM, *Entom. Tidsk.*, **14** : 157-194 (?).

1928. *Frankliniella intonsa*, PRIESNER, *Die Thysanopteren Europas*, p. 251-256 (Full references).

So far only one species of *Frankliniella* Karny, viz., ***sulphurea*** Schmutz (1913) was known to occur in India. It is the commonest Indian thrips and is almost entirely restricted to the Indian region. *Frankliniella intonsa* (Trybom) is the second species of the genus now found in India. This is a widely distributed species and is known to occur almost all over Europe and Siberia.

F. intonsa differs from *F. sulphurea* in that the 2nd stylar segment is only very slightly longer than the basal stylar in the former, while it is distinctly longer in the latter species; general body color grey-brown suffused with yellow and abdomen dark greyish-brown in the former while the entire body is almost uniformly pale yellow in the latter, and in the former (unlike in the latter) the eyes are protruding and provided with a thick colorless shell.

Collected from berseem (*Trifolium alexandrinum*) plants in Pusa (Bihar), in February 1941 by C. K. Samuel.

Euphysothrips Bagnall

1926. *Euphysothrips*, BAGNALL, *A.M.N.H.*, (9) **18** : 646.

1939. *Megaphysothrips*, RAMAKRISHNA & MARGABANDHU, *Rec. Ind. Mus.*, **41** (1) : 25. new synonym.

1939. *Euphysothrips*, RAMAKRISHNA & MARGABANDHU, *Rec. Ind. Mus.*, **41** (1) : 27.

Bagnall's original description :—

"Near *Physothrips*; head widening from behind eyes to base; antennae with two-jointed style; mouth-cone long, reaching across the prosternum; maxillary palpi 3-segmented, long. *Two pairs of long post-ocular bristles.* *Two long bristles at each hind angle of the pronotum, *the outer much longer than the inner. Lower vein of forewing without a regular series of setae, but with a few scattered ones.* Fringe of abdominal segment 8 long."

From the description of the type species, *Eu. minozzii* Bagnall (*loc. cit.*), it is seen that the lower vein has only four long setae and the pronotum has posteromarginal and inter-posteroangular setae a little more than half as long as the inner postero-angulars.

The generic description of *Megaphysothrips* Ramk. & Marg. runs as follows :—

"....the lower vein with only four but exceedingly long bristles ; there is practically only one long postero-angular bristle on prothorax, the second being much smaller; hind margin with six pairs of additional bristles. The genus is also characterised by the presence of a long incurved post-ocular spine characteristic of *Euphysothrips* Bagnall."

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* The italics are Bagnall's.

From the description of the type species, *M. subramanii* Ramk. & Marg., it is also seen that the 8th abdominal tergite has a strongly developed ciliary fringe at its hind border.

Thus there is no difference between the two genera, except the longer mouthcone in *Euphysothrips* than in *Megaphysothrips*, and the longer and slightly stouter spines on the lower vein of the fore wing in *Megaphysothrips*. These are not of generic value, and therefore *Megaphysothrips* Ramk. & Marga. is a synonym of *Euphysothrips* Bagnall.

Euphysothrips subramanii (Ramk. & Marg.)

1939. *Megaphysothrips subramanii*, RAMAKRISHNA & MARGABANDHU, *Rec Ind. Mus.*, **41** (1): 25, 26.

A study of the type of this species has necessitated the following ammendment being made to the original description :—

Wing chaetotaxy : Costa with 20-23 spines, upper vein with 3+3+1+1+1, lower vein with 4 and scale with 5+1 spines.

Length of antennal segments 1-8 (in μ) : 19 : 33 : 63 : 58 : 40 : 40 : 8 : 16.

Length of segments of maxillary palpi (in μ) 18 : 14 : 16.

Length of outer postangular prothoracic seta 51 μ

,, ,, inner ,, ,, ,, 35 ,,

,, postmarginal prothoracic setae 22 ,,

This species differs from the genotype *E minnozii* Bagnall in the following characters :

(i) The 5th antennal joint is much smaller than the 6th in *minnozii*, relatively in *subramanii* these two segments are equal;

(ii) The antennal style is 0.4 as long as the 6th segment in *minnozii* while in *subramanii* it is 0.6 as long.

(iii) Wing chaetotaxy :	Costa	upper vein	lower vein.
subramanii	20-23	3+3+1+1+1	4
minnozii	17	(2+2 or 2+3)+4	4

(iv) *E. subramanii* is slightly a larger species than *minnozii*.

Thrips (Oxyrrhinothrips) beharensis Ramk. & Marg.

1939. *Oxyrrhinothrips beharensis*, RAMAKRISHNA & MARGABANDHU, *Rec. Ind. Mus.*, **41**, (1): 29, 30.

1939 *Oxyrrhinothrips rostrata*, RAMAKRISHNA & MARGABANDHU, *Rec. Ind. Mus.*, **41**, (1) : p. 30.

Priesner (1933)[1] erected *Oxyrrhinothrips* as a subgenus of *Thrips* Linn. differing from *Thrips*, s str. only in having an extremely long and thin mouthcone. In view of the fact that there is no other significant difference it is unreasonable to raise it to the status of a genus as has been done by Ramakrishna and Margabandhu.

After a careful study of the two female type specimens of *beharensis* (Reg. No. 1053/H8 Z. S. I.) the following is added to the original description of the species.

Hind ocelli placed close to the inner hind border of eyes. A conspicuous postocular seta about a third of the length of the eye behind it. Interocellar bristles dark, moderately long, placed in front of hind ocelli. Moderately long setae strewn over the pronotum. Hind tibiae with a comb of spines on the distal half internally. Costal border of fore wing with 25 setae. The antenna is distinctly 7-segmented but the original description of the species gives measurements and colour of 8 ! ! ! segments. It is indeed difficult to understand wherefrom the 8th segment and the data therefor were obtained by the protologists.

The size of the antennal segments 3-7, as measured by Dr Hafiz and the author, are given below :—

Antennal segments	III	IV	V	VI	VII
Length in μ	49	52	35	45	16
Breadth in μ	16	16	15	16	7

As in *beharensis* inspite of the fact that in the type the antennae are clearly 7-segmented, description and measurements of 8 segments are again given by the protologists for *rostrata* !

The size of the antennal segments of the female holotype of *rostrata* (Reg. No. 1054/ H8, Z.S.I.), as measured by Dr. Hafiz and the present author, are given below :—

Antennal segments	III	IV	V	VI	VII
Length in μ	45	42	35	44	16
Breadth in μ	14	15	14	15	7

The author fails to detect any significant difference between *Oxyrrhinothrips beharensis* and *O. rostrata* either from descriptions or actual type specimens and he is therefore of the opinion that *rostrata* is only a synonym of *O. beharensis*.

Fulmekiola saccharicida Ramk. & Marg.

1939. *Fuemekiola saccharicida*. RAMAKRISHNA & MARGABANDHU. *Rec. Ind. Mus.*, **41** (1): 23, 24.

In the type series of this species (Reg. No. 1050/H8 Z.S.I.) the wing chaetotaxy is different from that given in the original description. It is as follows: Costa with 20-22 setae, upper vein with (3+3)+1+1+1 and the lower vein with 11 setae.

Deuterobrachythrips Schmutz

1913. *Heliothrips (Deuterobrachythrips)*, SCHMUTZ. *Sitzber. Akad. Wiss. Wien*, **122** p. 997.

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(1) Priesner, *Konowia 12*: 312 (1933).

1914. *Deuterobrachythrips*, KARNY, *Zeit. wiss. Insektenbiol*, **10**: 294,295.

1940. *Brachythrips*, RAMAKRISHNA & MARGABANDHU, (*nec.* O. M. Reuter) *Cat. Ind. Ins.*, **25** : 26.

Ramakrishna & Margabandhu have quite erroneously cited Schmutz as having erected *Brachythrips* while Schmutz actually erected *Deuterobrachythrips* as a subgenus under *Heliothrips* Haliday, with *D. lineata* Schm as type. Schmutz characterised the subgenus as follows: Head about one and a half times as broad as long. Eyes and ocelli present. In females the area between the eyes reticulated. Antenna (?). Maxillary palpi 3-segmented. Prothorax much longer than the head, in females with only slender hairs at hind angles, in males one seta each. Legs unarmed. Wings present in females, with a light longitudinal stripe. Fore wing without stout cilia on front margin between the fringes. Small insects about 1 mm. long.

Apterous males. Body surface, except only the vertex of females, devoid of net sculpture. It is difficult to retain *Deuterobrachythrips* as a subgenus of *Heliothrips* Haliday, as originally proposed by Schmutz.

In 1914 Karny suggested[1] that *Deuterobrachythrips* Schmutz was synonymous with his own *Rhamphothrips*[2] which he had defined as follows: Head distinctly broader than long. Antenna 9-segmented, style distinctly shorter than the 6th segment. Ocelli distinct. Mouth-cone extraordinarily long and very narrow, surpassing the anterior border of mesosternum, much longer than the remaining part of the head. Maxillary palpi very long and thin, 3-segmented. Prothorax broader and much longer than the head, each of its hind angles with 2 short setae. Anterior femora extraordinarily incrassate; anterior tibiae and tarsi each armed with a tooth. Fore wing with moderately sparse and not very stout setae. Body without net-like sculpture and without silky lustre. Abdominal end pointed, not thorny but with stout setae.

The armed fore tibiae and tarsi, the thickened fore femora and the two short setae at each hind angle of prothorax of *Rhamphothrips* Karny, as against the unarmed tibiae and tarsi, slender fore-femora and either slender hair (female) or only one seta (male) at hind angles of prothorax, preclude sinking *Deuterobrachythrips* Schmutz as a synonym of *Rhamphothrips* Karny. In the opinion of the present author, it has very close relationship with *Anaphothrips* (*Hemianaphothrips*) Pr.

Gnomonothrips (Ramk. & Marg.) Shumsher

1939. *Gnomonothrips*, RAMAKRISHNA & MARGABANDHU, *Rec. Ind. Mus.*, **41** (1): 28.

The original description of the genus is wholly incorrect. The genus is recharacterised below :—

Body without net-sculpture and silky hair. Slender. Head about as long as wide, widening basad; produced into an anterior antenniferous process between the eyes. Antennae 8-segmented; segments 3-6 very broad; ring-joints between

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(1) Karny. *Zeit. wiss. Insektenbiol.*, **10** : 294.295 (1914).

(2) In *Zool. Anzeig.*, **60** p. 297 (1912) Karny erected this genus under the name *Rhynchothrips*, but finding this name already occupied by a Tubuliferan genus of Bagnall. he renamed it *Rhamphothrips* in *Bull. Jard. bot. Buitenzorg*, **10** : 123 (1913). Type species of this genus is *R. tenuicornis* Karny (1912).

segments 2/3, 3/4 and 4/5; segments 3 and 4 with forked sense-cones; terminal style of antenna slightly shorter than the 6th segment. Eyes very slightly projecting but not prominent. Mouth-cone broadly rounded, surpassing middle of prosternum. Maxillary palpi 2-segmented, short, slender. Ocelli in an equilateral triangle situated before the middle of the eyes. Wings developed (female); with two longitudinal veins in each fore wing, the upper vein with a discontinuous row of setae. Prothorax with only two long setae at each hind angle. Fore femora somewhat incrassate. Legs unarmed. Tip of abdomen conical. Male not known.

The protologists have characterised it as coming very close to *Rhaphidothrips* Uzel, but the antennae being different......The present author, however sees no points of similarity between the two genera except the attributes common to almost all Terebrantia. The antennal style is much longer than the 6th segment in *Rhaphidothrips* but distinctly, though slightly, shorter in *Gnomonothrips*; maxillary palpi are 3-segmented in the former but only 2-segmented in the latter. In fact, this genus closely resembles *Diarthrothrips* Williams[1] in possessing the antennal ring-joints, 2-segmented maxillary palpi, shape and extent of mouth-cone, feeble armature and general shape of the body, the presence of long setae only at hind angles of pronotum and in many other respects. The points of difference, which appear significant, are that the ocelli are placed before the middle of the eyes in *Gnomonothrips* but almost at level with the hind margin of the eyes in *Diarthrothrips*, and the antennae in the former are short and thickset as compared with those of the latter. The anterior process of the head suggests close affinity of both these genera with *Albertothrips* Shumsher, from which however both these genera differ in having two setae at each prothoracic hind angle instead of one, and in not having extraordinarily strong setae at the tip of the abdomen.

Genotype *G. coimbatorensis* Ramk. & Marg.

Gnomonothrips coimbatorensis, (Ramk. & Marg.) Shumsher

1939. *Gnomonothrips coimbatorensis*, Ramakrishna & Margabandhu, *Rec. Ind. Mus.*, 41 (1): 28, 29.

Finding the original description of the species wholly inadequate and in some parts incorrect the author has redescribed the female holotype hereunder (Reg. No. 1052/H8, Z. S. I.)

General body color grey-brown suffused with yellow, with reddish hypodermal pigment shining through in the thorax. Eyes black in transmitted light, reddish-maroon in reflected light. Ocelli orange-yellow with brownish-red pigment cups. Fore femora towards the outer margin, and the mid and hind femora except basad, dark yellowish-brown; all tarsi, the fore tibiae and distal third of hind tibiae light, and the rest if the tibiae dark yellowish brown. All setae of the body pale yellowish-brown. Fringes of the wings brown. Wings pale brownish-yellow.

Head about as long as broad at base, where it is widest, gradually arched forwards, slightly constricted behind the eyes and produced forwards between them into a four-tipped antenniferous process. Eyes oval, about as

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(1) Williams, C.B., *Bull. ent. Res.*, 6: 269 (1915).

long as cheeks, and about 0.3 as wide as the head. Occiput very faintly cross-striate. Cheeks devoid of setae, except for one short slender seta a little behind the eyes. One seta of similar size at the junction of the cephalic process with the front margin of the eyes. Front ocellus in the middle of the cephalic process; hind ocelli in front of an imaginary line running across the middle of the eyes and removed from the inner margin of the latter by less than their (of the ocelli) own width. Interocellar setae between the front ocellus and each hind one. About five setae of varying lengths arranged in an arch behind each eye. Mouth-cone broadly rounded, reaching beyond the middle of the prosternum. Maxillary palpi 2-segmented, short, slender; basal segment the thicker and shorter. Antennae 8-segmented, basal segments short and broad; 2nd cup-shaped; 3rd-6th very broad, oval; 7th short barrel-shaped and 8 rod-like. Segments 3 and 4 with forked, long, stout sense-cones; ring joints between segments 2/3, 3/4 and 4/5. The style only a little shorter than the 6th antennal segment.

Pronotum with front and hind margins almost straight and parallel, sides arched, hind angles rounded. The front and hind margins fringed with slender setae, of which, two at each hind angle are very much the longer. Slightly shorter than the head and about 1½ times as broad as long.

Pterothorax broader than prothorax and a little longer than broad, broader in front than behind, constricted in the middle; angles rounded.

Legs unarmed, the tip of tibiae provided with two thick short spines on the inner side, those on the mid pair smaller and weaker than those on the hind pair, but longer and stronger than those on the front pair. Surface of legs sparsely and minutely setose. Fore femora incrassate.

Wings reach only about the 6th abdominal segment. Fore wing with front margin straight, to meet which the hind margin curves forward towards the tip. Two longitudinal veins in each fore wing. Costa with about 15 long, widely spaced spines, upper vein with 3+3+2+1+1, lower vein with 9 spines. The row of the lower vein starts opposite the last seta of the second group of 3 on the upper vein. A row of 3 tiny setae beneath the central seta of the basal group of 3 on the upper vein.

Abdomen slender, elongate, narrowed at base, almost uniformly broad from segments 3-7, thence tapering to a point. The 3rd and 4th sternites with a small, roughly circular central depression. Six long setae placed equidistant along the hind margin of sternites 1-7. Pleurites without zig-zag posterior border. Tergites 1-7 with a complete, though sparse fringe of broad cilia on hind border. The lengths of postero-lateral setae progressively increasing from segment 3-8; the 9th segment with very long slender setae, the 10th with slightly shorter ones.

Measurements of the female holotype:

Total length of the body nearly 1.14 mm.

	Length	Breadth
Head	0 124 mm.	0.122 mm.
Projection of head in front of eyes	0.025 mm.	
Eyes	0.050 mm.	
Dorsal interocular space		0.050 mm.

	Length.	Breadth.
Prothorax	0.120 mm.	0.152 mm.
Outer postangular seta of prothorax	0 030 mm.	
Inner ,, ,, ,, ,, ,,	0.050 mm.	
Pterothorax	0.200 mm.	0 210 mm.
Wing (excluding fringes)	0 500 mm.	
Abdomen		0 215 mm.
Maxillary palpal segments basal	8 μ	5 μ
,, ,, ,, apical	12 ,,	3 ,,

Antennal segments	III	IV	V	VI	VII	VIII
Length in μ	32	41	25	41	12	22
Breadth in μ	26	24	18	20	8	7

The ring-joints have not been included in the above measurements; their lengths are given below :—

Ring-joints	2/3	3/4	4/5
Length in μ	8	6	4

ON THE BIOLOGY OF *ANARSIA LINEATELLA* ZELLER IN BALUCHISTAN

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INTRODUCTION

Anarsia lineatella Zeller (Gelechiidae, Lepidoptera), generally known as the peach twig borer in the United States of America, is fairly common in Baluchistan and in recent years the extent of damage by its larvae to fruit trees has increased so enormously that it has now become a pest of first rate importance. A brief account of this insect was given by Janjua and Samuel (1941), but in view of its importance, the writer has since made a detailed study of the biology of the insect during the last four years and the results are presented in this paper.

The writer feels indebted to Dr. Khan A. Rahman, Government Entomologist, Punjab, for his valuable criticism ; to Mr. A.M. Mustafa, Director of Agriculture, Baluchistan, for his able guidance during the progress of work and to the Imperial Institute of Entomology, London, for the identification of the species.

DISTRIBUTION

The genus *Anarsia* is widely distributed throughout the world. In India, it is represented by about a dozen species, majority of which feed on leguminous crops. The larvae of *Anarsia epippias* Meyrick have been found feeding on groundnut, indigo, soybean, etc. and those of *Anarsia melanoplecta* Meyrick boring mango buds and twigs and feeding on mango inflorescence (Fletcher, 1920). The larvae of *Anarsia sagmatica* Meyrick have been observed boring in the flower-buds and feeding on the flowers and young leaves of *Loranthus* (Fletcher, 1932). *Anarsia lineatella* Zeller occurs in Central and Southern Europe, Asia Minor, Iraq, North Africa and North America, where it is a well-known pest of peach and of various species of *Prunus*, the larvae boring into the shoots and fruits. In India, it was first recorded from Kashmir (Fletcher, 1932), and later on from Baluchistan (Janjua and Samuel 1941) where it is common in almost whole of the districts of Quetta-Pishin, Zhob and Loralai. It is also present at Mastung and Kalat.

FEEDING HABITS

In Baluchistan, the larvae of *A. lineatella* have been observed damaging peach, nectarine, plum and apricot. The injury caused by the larvae may be described under the following two heads: (1) Damage caused to buds, tender shoots and twigs; and (2) Damage to fruit.

The partly grown overwintering larvae emerge from their winter hibernacula in spring and after crawling about for a couple of days, go to the base of a bud or in between the expanding leaves and begin to eat their way down into the tips of the twigs. The most usual manner of attack by the larvae, however, is to burrow into the new shoots, where they feed on the pith and inner bark, thus killing the shoot. These shoots ultimately dry up and break off. When the larva reaches the harder wood, it bores its way out, leaving a circular exit hole in the side of the twig. Each larva may attack several shoots in this way and thus multiply the injury. By destroying the terminal growth of a shoot, serious injury is done, particularly to nursery trees and in young orchards. Three or four larvae may devitalize or even completely destroy a young tree by repeated attacks on the new growth.

As regards damage to the fruit, the larva enters the young fruit either from the stalk end or from the side. After gaining entrance, it begins to eat out the flesh, making a large hole which gets filled with a gummy substance. The larva ultimately works its way straight to the pit, and if the latter is not already hardened, the larva bores through to the kernel and eats that with relish. When the larvae have penetrated to the pit, their presence may be detected by small bits of masticated fruit and gum which are thrown out by the insects on the surface of the fruit through the hole already made. As a result of the attack, the inner portion of the fruit becomes black due to the growth of mould and the presence of dark excreta, etc. Further growth of the fruits is checked and they become emaciated and very often fall to the ground even with moderately strong winds. If, however, the fruit matures, the attack leads to the "splitting of stones". Serious injury is evident only on clingstone peaches like *wiggins*, *shahpasand*, *kojak*, *lalarukh*, etc. Of the apricots, the larvae attack only the *charmaghz* variety while the French varieties, viz., *moore-park*, *reumberto*, *luizet*, etc. are not attacked at all. Nectarines and some varieties of plums are very susceptible to the attack. It has been estimated that 10-15 per cent of the fruits are spoiled by these larvae.

DESCRIPTION OF VARIOUS STAGES IN THE LIFE-HISTORY

The Egg:—The eggs are laid singly but occasionally they are also seen in batches of two or three. They are deposited on newly developing shoots, young twigs and fruits and are firmly attached to the surface by a sticky substance. The egg is long, oval in shape, pearly white, like tiny droplets of water when freshly laid and about twice as long as broad. The average length is 0·45 mm. and width 0·25 mm. Under the microscope a rather coarse reticulation is seen on the surface. The colour of the egg ultimately changes to deep yellow, and to almost orange colour when the egg is quite conspicuous. In four or five days old egg, the process of the development of the embryo can be seen through the thin egg-shell. A few days before hatching, the mandibles and other mouth parts are evident; shortly afterwards, the head and thoracic shield are seen. The larva finally emerges by cutting a hole in the chorion with its mandibles.

The Larva:—Almost immediately after hatching, the tiny larva moves about and nibbles a little of the leaf tissue here and there. Eventually it reaches the new shoot or young fruit in which it starts boring in, gaining in size as it feeds A larva may feed in more than one twing before it completes its growth. The entrance holes made by the larvae on fruit can be easily detected due to "frass" mixed with gum exuding from these holes.

The number of instars and the moulting activities of the larvae have been studied in detail. Six larval instars have been noted in Baluchistan and the description of the various instars is as follows:—

First instar :—Length soon after hatching 1·02 to 1·2 mm. Head 0·2 mm. wide. General body colour when newly hatched white. Shape cylindrical, gradually tapering posteriorly. Head pale brown; epicranium and frons dark, smoky brown with the ocellar areas deep brown, sutures deep and prominent, adfrontal sutures indistinct Mouth parts red-brown, antennae and maxillae somewhat pale. Thoracic shield dark brown. Tubercles indistinct, unicolourous with the body, each bearing a short seta. Thoracic leg, anal plate and prolegs concolorous with the body. Each proleg bears 6 or 7 pale brown crotchets in uniordinal series. Spiracles indistinct. Body covered with numerous minute hair arising singly.

Second instar:—Length soon after moulting 2·9 to 3·2 mm. Head 0·39 mm. wide. General body colour yellowish white. Head, epicranium, frons, maxillae, antennae and thoracic shield of the same colour as in previous instar. Tubercles faintly elevated, unicolorous with the body, each bearing a short seta. Thoracic legs, anal plate and prolegs concolourous with the body. Each proleg bears twelve or thirteen golden-brown crotchets in uniordinal series. Spiracles distinct and prominent.

Third instar :—Length soon after moulting 5·1 to 5·6 mm. Head 0·45 mm. wide. General body colour pinkish white. Head, epicranium and frons dark brown to black. Epicranial sutures somewhat black, adfrontal sutures indistinct. Mouth parts dark-brown. Thoracic shield shining dark brown Tubercles faintly elevated, unicolourous with the body, each bearing a short seta. Thoracic legs and prolegs yellowish-white; anal plate concolorous with the body. Each proleg bears sixteen to eighteen crotchets in uniordinal series. Spiracles small, round and ringed with black.

Hibernation takes place in this instar.

Fourth instar :—Length soon after moulting 6·9 to 7·2 mm. Head 0·53 mm. wide. General body colour light pinkish. Head of the same colour as in the previous instar. Thoracic shield brown. Tubercles more distinct, raised, unicolourous with the body, each bearing a short seta. Thoracic legs and prolegs yellowish-white, the former faintly tipped with dark brown. Anal plate occasionally a shade darker than the rest of the body, though never really darker or prominent, furnished with long hair. Each proleg bears twenty to twenty seven crotchets in uniordinal series. Hair short, white and sparse. Spiracles raised, darker than general body colour and surrounded by a dark ring.

Fifth instar :—Length soon after moulting 8·2 to 9·1 mm. Head 0·68 mm. wide. General body colour pink. Head and thoracic shield of the same colour as in the previous instar, adfrontal sutures being now distinct. Tubercles tipped with black, each bearing a moderately long silky hair. Thoracic legs, anal plate and prolegs of the same colour as in previous instar. Each proleg bears thirty-one to thirty-five crotchets in an irregular biordinal series. Spiracles raised, circular, with dark rim.

Sixth instar (Full grown larva) :—Length 12 to 14 mm. Width of the head capsule from 1·05 to 1·15 mm. General body colour reddish-pink on dorsal side fading into dull yellow on the second and third segments. Undersurface of dull whitish colour, becoming faintly reddish on the hinder segments, with a few shining whitish dots. Head rather small, flattened, bilobed, pale brownish-yellow, darker in colour about the mouth and with a dark brown dot on each side. Thoracic shield dark brown. Mouth parts brown, lighter than head; antennae pale at base, darker at tips. Tubercles faintly elevated, arranged in imperfect rows, a single one across the third, fourth and terminal segment, and a double row on the remaining segments; each tubercle gives rise to single, very fine, yellowish hair, invisible without a magnifying lens. Thoracic legs and prolegs yellowish-white, the former faintly tipped with dark brown Each proleg bears forty to forty-five crotchets in biordinal series. Anal plate a shade darker than the body, furnished with hair. Spiracles prominent, round, with dark rim.

When the larva is about to pupate, it seeks a secluded spot and spins a characteristic silk web over the entrance to the place of concealment and forms an extremely flimsy web out of a few threads of whitish silk, which serve only to hold the pupa in position rather than to protect it. The abdomen of the pupa is attached to this support by a little button of silk.

The Pupa :—Length 6 to 7 mm., width 2·1 to 2·5 mm. across the wing covers on the third abdominal segment. Shape rather broad at the anterior end, the abdomen tapering gradually towards the posterior end and terminating in a rounded segment. General body colour dark brown, the abdomen being a shade lighter than the body. Wing covers extend up to the anterior ventral margin of the 4th abdominal segment where they are conjointly rounded in an arc. Spiracles prominent, round, pimple-like, darker in colour than abdomen. On each of the abdominal segments there are two transverse rows of spines, a row of strong spines on the anterior margin and a row of weaker spines across the middle of each segment. The last segment bears on the dorsal side ten strong spines at the tip. The cremaster is absent and the anal segment has eight bristles which are incurved at tip. The maxillary palpi are about twice as long as the labial palpi and completely enclose the latter. Antennae comparatively long, reaching nearly the edge of the wing pad. Abdominal segments pronounced, bearing many silkly hair.

The empty pupal shell remains within the flimsy web when the moth emerges.

The Moth :—The moths are seldom observed, being very small and extremely quick in their movements and flying with great rapidity when disturbed. They fly at dusk only; at other times of the day they hide in crevices or dark recesses of the tree. They are dark steel gray in colour. Clemens (1860) describes the adult as follows :—

> "Head and face pale gray. Thorax dark gray. Labial palpi dark fuscons externally, and pale gray at the end; terminal joint gray, dusted with dark fuscous. Antennae grayish, annulated with dark brown. Fore wings gray, dusted with blackish-brown, with a few blackish-brown spots along the costa, the largest in the middle, and short blackish-brown streaks on the median nervure, subcostal in the fold, and one or two at the tip of the wing; cilia fuscous gray. Hind wings fuscous gray; cilia gray tinted with yellowish."

DURATION OF VARIOUS STAGES AND SEASONAL-HISTORY

The seasonal history of *Anarsia lineatella* varies considerably under different climatic conditions. In the United States of America, at certain places, such as the Pacific Northwest (Newcomer, 1933), Illinois (Chandler & Flint, 1935) and Michigan (Hutson, 1933) there are two broods in a year, while in Oregon State (Wilson, 1915) there are one to three broods and in Colorado (List & Newton,

1936) there are even four broods. In California, Essig (1915) reports that the insect has but one uneven brood in a year, while Duruz (1923) has found three broods and sometimes even a fourth. As a result of investigations carried out by the writer during the last four years, it has been ascertained that there are three generations of the insect in a year in the Quetta Valley. The studies were started with the first brood eggs deposited during 1937.

FIRST GENERATION

Observations during the four years 1937 to 1940 (Table I) show that oviposition commenced between 2nd & 9th May and ended between 6th & 14th June. The incubation period varied from 6-11 days with an average of 8-9 days. Hatching commenced between 10th & 15th May and ended between 15th & 21st June. The feeding period of larvae ranged between 20 to 35 days with an average of 29·8 days. At the end of the feeding period the larvae seek sheltered places in old pruning wounds, in curls of bark, in rough crevices on the main trunk of the tree or in curled leaves and start forming an extremely flimsy web in which it pupates. The prepupation period, which begins from the time the larva stops feeding and ends with pupation, varied from 4 to 9 days with an average of 7·9 days.

Pupation commenced between 18th and 26th June and ended between 15th and 21st July. The pupal period varied from 9 to 14 days (average 12·7). Emergence of adults began between 30th June and 8th July and ended between 28th July and 3rd August. The average adult life was 7·8 days.

Copulation takes place soon after the adults emerge. It lasts from an hour to an hour and a quarter, and invariably takes place at night. The preoviposition period varied from 2 to 5 days with an average of 3·5 days. The average time of egg deposition was 5·8 days, varying from 3 to 8 days.

The egg laying activities of the moths were observed in detail. Oviposition usually occurs either in the morning or just after sunset and as the time for oviposition approaches, there are indications of excitement on the part of the female. After sometime she becomes quiet when the apex of her abdomen touches the surface on which she rests. She slowly lifts the tip of her abdomen and lays an egg. This process is repeated again and again until several eggs are laid in succession. The average number of eggs deposited by the first brood moths was 169·5; ten females depositing 1,695 eggs. The maximum number of eggs deposited by a single female was 232. The life cycle of the first generation varied from 43 to 69 days with an average of 59·3 days.

SECOND GENERATION

During the years 1937-40 (Table I), the first eggs of second brood were deposited between July 2 and 10 and oviposition continued up to August 1 to 6. The incubation period of the eggs varied from 4 to 8 days with an average of 6·7 days. The eggs commenced hatching between July 12 and 19 and continued upto August 4 and 11. The feeding period of larvae ranged from 18 to 27 days with an average of 24·4 days. The prepupation period varied from 3 to 8 days with an average of 6·4 days. The first pupation took place between August 3 and 11 and the last between September 1 and 9. The pupal period varied from 6 to 10 days with an average of 8·7 days.

During the four years the first moths of the second brood emerged between August 12 and 21 and the last between September 7 and 14. The length of life of the adult fed on glucose syrup in laboratory varied from 5 to 8 days, the average being 7·1 days during August-September, 1940.

The pre-oviposition period varied from 2 to 5 days with an average of 3·2 days. The average time of egg deposition was 5·6 days varying from 3 to 7 days. The average number of eggs deposited per female of the second brood was 143·7, ten females depositing 1,437 eggs. The maximum number of eggs deposited by a single female was 203. The life cycle of the second generation varied from 40 to 63 days with an average of 51·4 days.

THIRD GENERATION

During the years 1937-40, the first eggs of the third generation were deposited between August 15 and 23 but oviposition ended between September 10 and 18. The incubation period of the egg varied from 7 to 11 days with an average of 9·3 days.

During the 4 years, eggs commenced hatching between August 24 and September 3, and finished hatching between September 20 and 27. The feeding period of the larvae of this brood before going into hibernation ranged from 22 to 30 days, with an average of 27·5 days.

On the onset of autumn, the larvae begin to desert the fruit, the twigs or the shoots and go into hibernation. The earliest date on which the larvae were found entering hibernation in 1937 was September 29, in 1938 it was October 1, in 1939 it was September 26 while in 1940 it was September 27.

The partially grown larvae pass the winter in small silklined burrows or hibernacula made just beneath the outer bark. These are usually constructed in the crotches of younger branches and are always found on the upper surface. Each burrow has a characteristic small reddish brown projecting tube or "chimney" sticking up from the surface of the bark. These chimneys are very small, difficult to be seen without a lense and are composed of tiny pieces of bark fastened together with silk. The hibernacula are usually 10-12 mm. long and vary greatly in shape, some being straight, others curved to conform to the space in which they are constructed. They are always found singly, though sometimes two or three may be seen near each other. On cutting into one of these hibernacula, it is found that they extend well beneath the bark into the cambium layer and has a silk lining inside which projects well up into the chimney above. This silk lining affords protection from the weather.

Securely enclosed inside these burrows, the larvae pass the winter and with the approach of spring, when the buds begin to swell and the development of the tender shoots and foliage starts, they become active and work their way out of the hibernacula. In 1938, the first larva emerged on March 30 and the last on April 26; in 1939 the first larva came out on April 4 and the last on April 28; in 1940 emergence started on April 2 and continued up to April 30, while in 1941 the first larva emerged on April 1 and the last on April 24. The length of time spent by the larvae in hibernation ranged from 178 to 193 days, with an average of 185·2 days. During 1937-38 it was from 178 to 189 days, in 1938-39 from 180 to 192 days, in 1939-40 from 182 to 193 days, while in 1940-41 it was from 185 to 190 days.

On emerging from their winter quarters the larvae attack the developing buds, tender shoots and young twigs, etc. The feeding period of these larvae ranged from 17 to 25 days with an average of 21·6 days.

The prepupal period varied from 5 to 8 days with an average of 6.3 days.

During the 4 years first pupation took place between April 20 and 27, and the last between May 14 and 22. The pupal period varied from 10 to 14 days with an average of 13·3 days.

In 1938, the first moths of the third brood emerged between May 3 and 9, and the last between June 2 and 12. The length of life of the adult fed on glucose syrup in laboratory varied from 6 to 9 days, the average being 8·0 days during May-June, 1940.

The pre-oviposition period varied from 2 to 5 days with an average of 3·8 days. The average time of egg deposition was 6·1 days varying from 4 to 8 days. The average number of eggs deposited per female moth of the third brood was 158·2 ; ten females depositing 1,582 eggs. The maximum number of eggs deposited by a single female was 227.

The life cycle of the third generation varied from 239 to 281 days with an average of 263·2 days.

PARASITES

The larvae of *Anarsia lineatella* have been found to be heavily parasitized by the chalcidid, *Brachymeria intermedia* (Nees).

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TABLE I

Life-History Data of Anarsia lineatella (1937-40).

Year.	1st egg deposited on.	Oviposition ended on.	Incubation (days) Range—Mean.		Hatchinng of eggs.		Feeding period of larvae. (days) Range Av.		Prepupal period (days).	Pupation.		Pupal period Range Av. (days).		Emergence of adults.			Life of Adult (days)	
					Commencement.	End				Commencement.	End.			Commencement.	End.		Fed Av.	Life cycle.
					First Generation.													
1937	2. V	6. VI	7-9	8·9	10. V	15. VI	29-35	29 8	4-8	18. VI	15. VII	9-12	12·7	30. VI	28. VII	7·8	45	66
1938	6. V	11. VI	6-10		12. V	19. VI	23-32		6-9	20. VI	17. VII	10-14		2. VII	27. VII		43	57
1939	4. V	7. VI	7-11		14. V	16. VI	20-33		5-9	22. VI	15. VII	11-14		5. VII	29. VII		47	63
1940	9. V	14. VI	6-9		15. V	21. VI	25-34		6-8	26. VI	21. VII	9-14		8. VII	3. VIII		50	69
					Second Generation													
1937	2. VII	1. VIII	5-8	6·7	12. VII	4. VIII	18-20	24·4	4-7	6. VIII	1. IX	6-9	8·7	15. VIII	7. IX	7 1	42	59
1938	5. VII	4. VIII	4-7		15. VII	6. VIII	20-27		3-8	9. VIII	3. IX	7-10		18. VIII	10. IX		40	60
1939	7. VII	3. VIII	6-8		17. VII	9. VIII	19-26		5-8	3. VIII	5 IX	6-8		12. VIII	14. IX		46	63
1940	10. VII	6. VIII	4-8		19. VII	11. VIII	20-25		4-7	11. VIII	9. IX	6-10		21. VIII	8. IX		49	62
					Third Generation													
1937	18. VIII	12. IX	8-10	9·3	28. VIII	23. IX	26-29	27 5		21. IV	16. V	11-13	13·3	3. V	2. VI	8·0	243	273
1938	21. VIII	15. IX	7-11		1. IX	26. IX	23-30			24. IV	19. IV	12-14		6. V	9 VI		250	273
1939	15 VIII	18 IX	9-11		24. VIII	27. IX	25-30			20. IV	14. IV	10-13		4. V	6. VI		239	269
1940	23 VIII	10 IX	7-10		3. IX	20. IX	22-28			27. IV	22. IV	10-14		9. V	12. VI		256	282

EARLIEST O ATIONS ON THE SWELLING OF INSECT EGGS AFTER OVIPOSITION—A HISTORICAL NOTE

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(Communicated by Dr. H. S. Pruthi, New Delhi.)

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I. INTRODUCTION

Who first discovered the swelling of insect eggs after oviposition? The present note is an attempt to answer this question.

In the paper on some recent advances in insect embryology, with a complete bibliography of the subject (1939), the writer had, following Needham (1934), stated (p. 19) that the phenomenon of the swelling of the eggs of certain insects after oviposition was known to Aristotle in the 4th century B.C. It would seem, however, as shown below, that while Aristotle certainly knew of true insect eggs, there is no positive and clear evidence that he knew of their swelling after oviposition.

The writer had further stated that the phenomenon was rediscovered by Rathke (1844) in the eggs of the mole cricket, *Gryllotalpa vulgaris* (Orthoptera), and of some caddis-flies (Trichoptera). Rathke attributed the swelling to the absorption of external moisture, without, however, bringing forward any evidence in support of that view. During the last hundred years such a swelling has been observed in the eggs of a considerable number of insects belonging to the orders Orthoptera, Dermaptera, Hemiptera, Hymenoptera, Coleoptera and Diptera (*vide* Roonwal, 1935).

Wigglesworth (1939, p. 2) also ascribed the first discovery of this phenomenon to Rathke.

There are, however, post-Renaissance records which ante-date Rathke's observations by nearly a century. These observations are by the renowned French naturalist and physicist, Réaumur, who had observed the phenomenon in the eggs of some saw-flies in 1740, and in those of some ants in about 1742-1743 (*vide* Wheeler, 1926). Rathke does not refer to Réaumur's observations of which he was probably unaware.

The writer will discuss below the Aristotelian position and the observations of Reaumur.

Acknowledgments:—The discussion on Aristotle owes much to Dr. J. Needham, F.R.S., of the Biochemical Laboratory, Cambridge, and I would like to thank him for the considerable trouble he took not only in examining the question *de novo* at my request, but also for sending me copies of relevant passages from the works of Aristotle. To Dr. B. N. Chopra, D. SC. of the Zoological Survey of India, I am thankful for going through the manuscript and for useful criticism. To Mrs. V. G. Deshpande I am indebted for checking my translations of some of the French passages of Réaumur here reproduced.

II. ARISTOTELIAN KNOWLEDGE

From Chart I on page 23 and some other passages in Needham's book (1934) it would appear that true insect eggs were known to Aristotle, and that he regarded the insect pupa also as an egg-stage.

Nordenskiöld (1928, pp. 42-43), however, maintained that true insect eggs were unknown to Aristotle. He summarised Aristotle's classification of animal eggs as follows:

"Warm and dry animals lay 'complete' eggs, such as osseans, frogs and ink-fish; and finally the lowest animals of all—that is, of those that propagate in a sexual way—breed worms which give rise to eggs, as, for instance, insects whose pupae Aristotle regarded as eggs, whereas the true insect eggs were unknown to him"

Some time ago I pointed out this discrepancy to Dr. Needham who replied (Jan. 16, 1941) as follows:

"The question you raise about the knowledge of Aristotle is very interesting. I have carefully gone into the matter, and my conclusion is that (as I said in my book[1]) Aristotle *did* know of the true eggs of some insects, and of their swelling during development[2] ('imperfect eggs'), a phenomenon which did not receive a clear explanation till our own time (cf. Slifer's 'hydropile')[3]—but that he was deceived by the pupa of other insects, called it also a kind of egg, and thought that the larva or scolex had not yet *become* an egg. As regards the sources of your confusion (1) my remark on p. 87-88 about Fabricius[4] was ment to indicate that he made an advance on Aristotle's scolex theory, not on his knowledge of 'imperfect', but true, insect eggs; (2) I think Nördenskiold is just simply wrong."

"....I had a typescript copy made of the whole section in the 'De Generatione Animalium[5] relating to the generation of insects and enclose it herewith. Most of it relates to bees, but this also may interest you. I have also had a copy made of Ogle's notes[6] on the same subject in his Introduction to his translation, and this accompanies the other."

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1. Needham, J. 1934. *A History of Embryology*. London.
2. As shown in this paper, there is no clear evidence that Aristotle knew of this swelling in true insect eggs.
3. Slifer, Eleanor, H. 1938. The formation and structure of a special water-absorbing area in the membrane covering the grasshopper egg. *Quart. J. micr. Sci.* **77**: 615-637.
4. Fabricius ab Aquapendente. H. 1687. *Opera Omina.* Goezius, Leipzig.
5. Aristotle. *De Generatione Animalium.* Transl. and edit. by A. Platt, 1912, Oxford.
6. Ogle, W. 1882. *Aristotle on the Parts of Animals.* (Transl., introduction and notes.) London.

"It looks as if Aristotle certainly knew of true insect eggs, but was perhaps misled by viviparous or larviparous flies, which would have given him a scolex with no obvious prior egg. He does not seem to be clear either about the distinction between an inset egg swelling by imbibition of water and an insect larva swelling by growth as a result of feeding."

I have examined the papers sent by Dr. Needham, and am able to confirm his view that Aristotle knew of true insect eggs. His other view that Aristotle also knew of the swelling of insect eggs, I differ from.

Aristotle's knowledge regarding insect eggs and their swelling may be summed up thus: (1) He certainly knew of the true eggs of some insects. (2) He was not at all happy about the distinction between the egg, larva and pupa. He regarded the pupa as the fully grown egg, and the true egg and larva—both of which he termed as the scolex, one non-motile, the other motile—he regarded as immature eggs. (3) In his "scolex theory" he maintained that there are two kinds of scolex: one capable of motion, in other words a grub or maggot; the other incapable of motion, and so exceedingly like an ovum in shape, size and consistency as to be indistinguishable from it, excepting by considering its ulterior changes (*vide* Ogle[1]). (This latter is the true egg.) Viviparous insects, such as the flesh-fly, produce the motile scolex, while ordinary oviparous insects produce the non-motile scolex. (4) The scolex of either kind he regarded as more immature than an ovum (*i e.*, pupa) because it *became* an ovum (*i.e.*, pupa), as in bees, wasps and butterflies. The explanation, according to Aristotle, lies herein that the nature of these animals is "imperfect", and so their eggs (true eggs) are produced before due time, the scolex (larva) being as it were an ovum, still soft and in process of growth, and ultimately leading to the fully-formed motionless egg (*i.e.*, pupa). (5) Finally, did Aristotle know of the swelling of true insect eggs? It is not clear. He of course knew of larval growth by feeding, regarding it as an egg-growth, but he was not clear about the distinction between this and the growth of the true egg swelling by the imbibition of water, because he regarded both the larva and true egg as immature eggs. Perhaps his mention of "imperfect" eggs which grow after being laid referred only to larval growth. At any rate, there is no positive and clear evidence to show that he knew of the phenomenon of the swelling of true insect eggs by the intake of water. In this connection, Dr. Needham subsequently (July 15, 1941) wrote to me as follows:

> "I agree with you in doubting whether Aristotle really knew of the true swelling of insect eggs, as opposed to the swelling of the larva as the result of its growth and feeding I was merely going on the footnote of one of the commentators .... which concludes he knew. It's not impossible that he observed it, is it? In some insects the observation would perhaps not be too difficult. He certainly had a class for eggs that swelled after being laid, and I've always assumed he had the Amphibia mostly in mind, where the process is very obvious, though we know it is only due to the egg-jelly."

III. REAUMUR'S OBSERVATIONS

(*a*) *Eggs of saw-flies* (1740).

Réaumur (1740) observed the swelling of the eggs of at least two species of saw-flies—one ovipositing in the stem of the rose-bush, and the other on the leaves of the wicker-plant. For the saw-flies he interchangeably used the expressions "mouche a scie" or fly with a saw, and "fausse chenille" or false caterpillar. The specific names of the saw-flies were not given. Reaumur wrote before the system of binominal nomenclature was introduced by Linnaeus.

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[1] See foot-note. p. 146.

Not content with the mere observation of the swelling phenomenon, Réaumur wanted to know the cause thereof His conjectures were both intelligent and penetrating. He suggested the following three possible causes of growth: (i) The egg-wall acts as a placenta and imbibes the juices of the plant on which the eggs are laid; the imbibition of the juices causes the egg to swell and also supplies nutriment to the embryo developing inside the egg. (ii) The egg is stuck on to the plant with some force and acts like a graft, tapping the juices of the host-plant. (iii) In cases where the eggs are laid on the leaf surface, and not in incisions, the moisture transpired by the leaf furnishes the wherewithal for the increase in size of the eggs; he showed experimentally that if the leaves were allowed to dry up, the eggs deposited on them also shrivelled. We know to-day that the last explanation of Réaumur is most probably the true one Peacock's (1928) experiments on the rearing of saw-fly eggs *in vitro* suggest that the imbibition of external moisture is the cause of egg-swelling, although some authors maintain that the increase is due to the intake, by diffusion, of food-material by the embryo While the latter theory has not been disproved, it is a most unlikely one for the reason that insect eggs usually contain an abundant supply of yolk to last throughout the embryonic development, and no external food is necessary. In Réaumur's days, however, such a conjecture was pardonable[1] That the imbibition of external moisture through the egg-wall is the real cause of egg-swelling has now been experimentally shown in a number of other insects, the percentage of water in fully-developed eggs being considerably higher than in freshly-laid ones (*vide* Roonwal, 1935, for some details).

Réaumur also noticed the late embryo inside the egg. He correctly recognised two black points as the eyes, and further noticed that the embryo was folded upon itself inside the egg.

The translation of the relevant passages from Réaumur (1740) are given below in the Appendix (pp. 150-151).

(*b*) *Eggs of ants (1742-1743)*

Réaumur's last (sixth) published volume of his *Memoire pour servir a l'histoire des insects* appeared in 1742. He had plans of completing the *Memoire* in ten volumes, but the remaining volumes never appeared in print, although it has long been known that Réaumur had completed at least one more volume after the sixth. Some years ago Prof. W. M. Wheeler discovered, among the unpublished manuscripts of Réaumur in the archives of the Academy of Sciences of the Institute of France, Paris, an almost complete manuscript on ants entitled *Histoire des Fourmis*. Wheeler (1926) brought forth evidence to show that it was completed sometime between the end of October 1742 and the end of January 1743, and that Réaumur had intended it to be the seventh volume of his *Memoire*.

The *Histoire des Fourmis* was first published, with English translation and annotations by Wheeler, in 1926. In it we find that Réaumur had observed that the eggs of ants, like those of the saw-flies, grow rapidly in size as they develop. The species of ants are not mentioned for reasons already stated for the saw-flies.

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[1] See foot-note to Appendix, p. 151.

As in the case of the saw-flies, Réaumur wanted to know the cause of the swelling of the eggs He suggested the following three possibilities: (i) The mother ant nourishes the eggs by moistening them with its mouth-parts. (ii) The black spot, which he noticed at one pole of the egg, functions as a mouth through which nutrition passes into the egg. (iii) The moisture imbibed through the egg-shell carries with it some nutritive juices.

The precise cause of swelling for ants is not known even to-day. Of course, there is no "mouth" at either pole of the egg of the ant. The swelling is most probably caused by the imbibition, through the egg-wall, of moisture derived either from the "saliva" with which the ants continually coat the eggs, or, what is more likely, from the soil and the atmosphere.

As late as 1915, Donisthorpe (p. 29) was not convinced that the increase in size in the eggs of ants actually takes place in nature by the absorption of external moisture To-day, by comparison with the cases of other insects, we need hardly doubt the truth of the phenomenon.

Réaumur also observed the late embryo in eggs about to hatch. He remarked that it was just like the freshly emerged larva, and that it occupied a considerable part of the space inside the egg, the remaining space being filled with a "liquid destined to nourish" the embryo. This again shows, as pointed out above, that Réaumur always sought to explain the nutriment of the embryo on the basis of nutritive *juices* (not yolk) either already present in the egg or imbibed from external sources.

IV. SUMMARY

1. While true insect eggs were known to Aristotle (4th century B.C.), there is no positive and clear proof that their swelling after oviposition, as a result of the imbibition of water, was known to him.

2. The swelling of insect eggs was first clearly observed by the renowned French scientist, Réaumur. He noticed this phenomenon in the eggs of some saw-flies (1740) and of some ants (1742-1743).

3. Réaumur attempted to explain the swelling largely on the basis of the imbibition by the egg of moisture and of nutritive juices derived from external sources, the former conjecture being to-day recognised as the correct one. He was probably unaware of the food-yolk contained in insect eggs.

4. Réaumur also observed the late embryos contained in the eggs of both the saw-flies and ants, but early embryos were unknown to him.

5. Subsequent to Réaumur, Rathke (1844) observed the swelling in the eggs of the mole-cricket and the caddis-flies.

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VI. APPENDIX.

The following translations from Réaumur (1740) give his observations on the saw-flies. My explanatory notes are enclosed within square brackets, whilst my annotations are given as footnotes

(i) *Saw-fly which oviposits on the rose-bush—pp. 121-122.* (*Translation*):—

" ... and one can compare this egg, as I have many times done, to an egg taken from a recent notch [in the stem] where the fly had deposited only a few hours ago: the egg taken out of the notch which [*i.e.*, the egg] is swollen appears to be considerably larger than the other. One, therefore, concludes that the egg has increased in volume after it has been laid, which might appear to us a great singularity. Indeed, these eggs do not have a hard and inflexible envelope like those of our fowl, but are covered only by a simple membrane; however, the eggs of the majority of other insects also have only membranous envelopes, and yet their eggs do not grow[1]. The egg of our saw-fly of course grows daily at the same rate, and corresponding to that growth the flaps of the cell in which it is enclosed are obliged to be raised; it is necessary for this cell to become considerably large in all directions. The fly places her eggs as if it foresees the coming events; although she likes to place them close to one another, she leaves a distance between two notches in order that there may be room for swelling without their [the eggs] encroaching upon one another.

"The egg, in growing and in necessitating the bark of the bush to elevate itself so as to become convex, forces the gap which has been made on the bark to become bigger. The opening widens more considerably day by day, and when the false caterpillar comes out of the egg, it [the slit] is such as to give it [the false caterpillar] a liberal passage, which is necessary for it [to allow it] to go in search of life on the rose-bushes."

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[1] Throughout this and the following translation, "growth" is intended to mean "swelling". the former expression being used to keep the translations and literal as possible.

(ii) *Saw-fly which oviposits on the wicker-plant—pp. 127-129.* (*Translation*).—

"It has been easier for me to observe in the eggs of the last-mentioned flies than in those of any others, how considerable is the growth which takes place in these false caterpillars. I have compared some of these eggs, the insect in every one of which being ready to come out, with others nearly newly laid; the first have at least double the volume of the second. Those which are laid only on the same day are oblong, rounded at the two ends, white and transparent; they have as an envelope only a thin and flexible membrane. After some days one sees inside them a yellowish part. When they are more advanced, one discovers in them two black points which one judges to be the eyes; finally, if one examines them on the great day when they are almost near their end [*i.e.*, about to hatch], one observes there the false caterpillar which appeared to me to be folded in two; during the last days the growth [of the eggs] ceases.

"What takes place [happens] to the worms [larvae] of these flies and to those of other saw-flies is certainly very remarkable. Is it that the shell of the eggs, its envelope, is a kind of placenta which saturates itself with the water that is imbibed from the juice of the portion of the plant on which it [the egg] is deposited, and that it is the juice which not only makes it [the egg] grow, but also provides for the growth of the embryo which it encloses?[1] Is an egg which has been deposited in a crevice in a stem of the rose-bush grafted with some force? Is it that it [the egg] absorbes the juice of the shrub in the same manner in which the bud of a tree, lodged in the notch made in another tree, appropriates to itself the juice of that tree? It resembles what may be this. Indeed, the eggs of some of the false caterpillars are found laid immediately on the leaves where no incision can be discovered; but it does not follow that these leaves have no power to furnish these eggs at least the humidity they [the leaves] allow to be transpired. I have done an experiment which proves decisively that it is essential to the egg that this humidity is furnished to it by the leaf. I have watched several times in the powder ["poudriers"] of the leaves of the wicker-plant on which there are the eggs of the false caterpillars. As the leaves get dried up, the eggs become similarly dried up, as has been noted by M. Bazin as also by myself. The eggs of butterflies which were laid on a leaf which would dry up [in course of time] did not in the least give that [dryness] to the caterpillars. I immediately decided to place into water the leaves on which there were the slits of eggs of the false caterpillars. By this means the leaves have conserved their freshness; the eggs also do not appear to have suffered in the least. I have seen the false caterpillars gaining strength at the end of four to five days, and some others at the end of six to seven days. I have observed some bunches of these eggs* (*pl. 11, fig. 9) composed of two layers which appears to form a great difficulty regarding the manner of nourishing the eggs of the second layer. At the same time, if the fly piles them thus, it means that she is able to do so without inconvenience. One should think that the humidity which rises from the leaf reaches the second layer of eggs, or that the eggs of the first layer furnish those of the second the excess of humidity that they have, and which suffices for those [*i.e.*, the eggs of the second layer]."

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[1] Réaumur apparently believed that the developing insect embryo needs a supply of nutritive *juices* from outside the egg. He was obviously unaware of the rich supply of food-yolk present in the eggs, and its function. Nor, of course, did he know what early insect embryos looked like—they were first observed 78 years later by Suckow (1818).

STUDIES ON INDIAN PARASITIC HYMENOPTERA—II*

By M. S. MANI, *Assistant to the Imperial Entomologist, New Delhi*

The types of the new forms described in this paper are deposited in the Imperial Pusa Collection, Laboratory of the Imperial Entomologist, Imperial Agricultural Research Institute, New Delhi.

Superfamily SERPHOIDEA
Family *SCELIONIDAE*
Subfamily TELENOMINAE
Liophanurus samueli, sp. nov.

Female.—0·8 mm. long. Black, 'lederatig', finely punctate, pubescent. Head viewed in front transverse, one-fourth wider than long, lateral ocelli contiguous with orbital border. Mandibles bidentatae as in figure 1. Antennae as in figure 3, club penta-articulate. Cheek finely striate. Scape, pedical and three segments of funicle, the first two segments of club yellowish-brown, rest of club black. Mesonotum and scutellum finely punctate, parasidal furrows absent; mesopleura glossy and smooth. Fore-wing somewhat browned in the region of radial vein in the middle. Legs: figures 6, 7, coxae concolourous with body, mid and hind legs honey-brown, except the brownish terminal segment of tarsi, fore femora dark brown, rest of hind legs as in others. Abdomen oval, longer than rest of body, first apparent segment with the usual longitudinal striations, second apparent segment devoid of the same.

Male.—Antennae as in figure 2, with a darker colour, except scape, which is brown, rest of antennae black Fore wing as in figure 4,5, the browning more prominent than in female, and distinctly transverse in the middle of the lamina.

Holotype one female, allotype one male, paratypes several males and females in spirit and some mounted on slides; bred from the eggs of *Bagrada picta* laid in soil, C. K. Samuel, New Delhi, 1. iv. 1942.

This is the first record of a parasite of *Bagrada picta;* the only other species of *Liophanurus* known from the Indian region was bred from the eggs of a Pentatomid bug on sugarcane leaves.

Superfamily CHALCIDOIDEA
Family *TORYMIDAE*
SUBFAMILY MONODONTOMERINAE
Holaspis indicus, sp. nov.

Female (figure 8).—2·5 mm long. Bright metallic green. Head viewed in front as in figure 9, the shaded area below the level of the lower orbital borders punctate and densely setose; viewed from above ocellocular space equal to ocellar diameter; lateral ocellar interspace thrice the ocellocular. Space between

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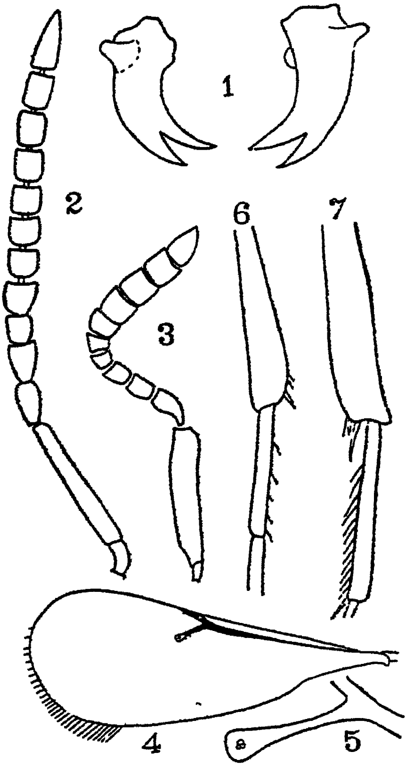
* Part 1 of this series was published in *Indian J. Ent.*, **3** : 25 (1941)

antennal sockets equal to that between the orbital border and the sockets, with a distinct carina between the sockets. Antennae : scape yellowish-brown; not reaching the front ocellus; rest shiny black and as in figure 10. Legs : coxae and femora concolourous with the body, knees and rest of legs except the slightly fumated tibiae yellowish-brown, terminal tarsal segment somewhat darker; subapical tooth of femur as in figure 11. Propodeum smooth, shiny. Ovipositor equal to length of abdomen.

Male—2 0 mm long. Punctation on face extending up to the middle of face. Legs entirely yellowish-brown.

Holotype one female on card, allotype one male on card; paratypes several females and males on card and one female on a slide. Received from the Forest Entomologist, Dehra Dun, labelled : "Bred from the flower bud galls of *Dalbergia sissoo;* Dehra Dun, P. N. Chatterjee 11. iv. 1941."



FIGS 1-7—*Liophanurus samueli*, sp nov. 1. mandibles of female; 2. antenna of male; 3. antenna of female; 4. wing of male; 5. venation more highly magnified; 6, 7. mid & hind legs of female.

The galled flower bud is shown in figure 12.

Family *EUCHARIDE*

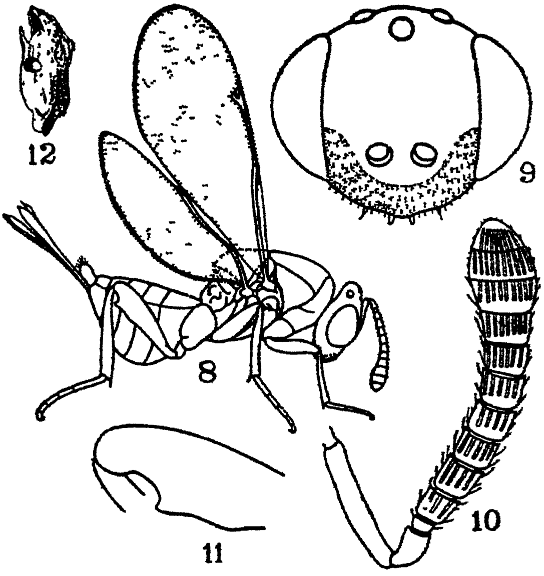
Kapaloides, gen nov.

This new genus differs from *Kapala, Neokapala* and *Lasiokapala* in having one additional antennal segment, *i e.*, 12 instead of 11. It approaches *Lasiokapala* very closely in the structure of scutellum and pubescence of thorax. The antennae are unequally biramose In other respects resembling the three above-mentioned genera. The 12 segments of the antennae are as below scape 1, pedicel 1, funicular segments 9, club 1, funicular segments all branched or the first simple, branches single or unequally forked in some segments. Scutellar processes with the forks broad and carinate

Genotype —Kapaloides travancorensis, sp. nov.

Kapaloides travancorensis, sp. nov.

Male (Fig. 13).—4 mm. long. General colour of body dark metallic green Head metallic green, uniformly pubescent, with a height about five-sevenths of the greatest breadth and somewhat broader than thorax, longitudinally striate in front between the eye and the anntenal foveae, the striations near the inner borders of the eye much longer and reaching lower down than those near the antennal foveae (fig 14) face below antenna and sides of cheek below eye smooth and not straited, antennal fovea transversely striate, sides of cheek below the eye densely punctate in the posterior aspect, the back of head transversely striate Eyes brown. Antennae dark brown, finely pubescent, as in (fig. 15) Sculpture in the middle lobe of memonotum reticulale and in the



Figs. 8-12.—*Holaspis indicus.* sp nov 8. female lateral view; 9 head viewed in front; 10. antenna of female; 11 hind femur of female showing the subapical dentation, 12 galled flower of *Dalbergia sissoo*, showing the exit hole (about×2)

lateral lobes transversely reticulo-striate. Pleura sculptured as in figure 13 Scutellum relatively small, sculptured similar to middle lobe of mesonotum, the median furrow not very deep. Scutellar process (fig. 16) narrow, not extremely widely separated, the carina moderately large Except coxae, which are metallic green, petiole of abdomen moderately long and longitudinally striate.

Holotype one male on pin, with antennae mounted on a slide. Maddathoray, base of Western Ghats, Travancore, 17. xi. 1908.

Kapaloides andamanensis, sp. nov.

Male—3 5 mm long General colour of body mostly dark green or very dark metallic green, somewhat relatively less thickly pubescent than the fore-going species. Head dark metallic green, somewhat more densely pubescent above than below, about as broad as thorax, with a height about three-fifth the greatest breadth; longitudinally striate in front between eyes and antennal fovea, above the level of attachment of antenna and never as low down as the lower level of eyes, the antennal fovea transversely striate; back of head transversely striate; sides obliquely striate behind, the striae continued as the transverse striations of the back, not punctate, smooth elsewhere. Eyes dark brown. Antenna as in figure 17 Mesonotum metallic green or greenish-black, coarsely sculptured, scutellum with a distinct median furrow and sculptured similar to mesnotum; scutellar processes broad and with rather broad carinae, widely separated from each other. Coxae dark testaceous brown, rest of legs brown. Abdomen dark coppery-brown, petiole black and irregularly longitudinally striate.

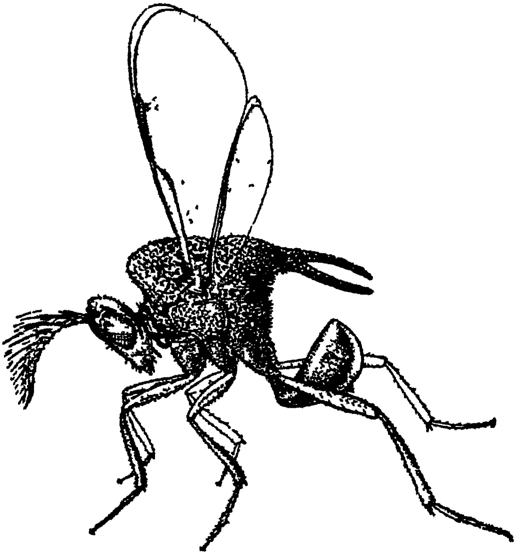


Fig 13.—*Kapaloides travancorensis*, sp nov.

Holotype one male on pin, with antenna mounted on slide. Port Blair, Andamans, iii. 1915.

Key to species

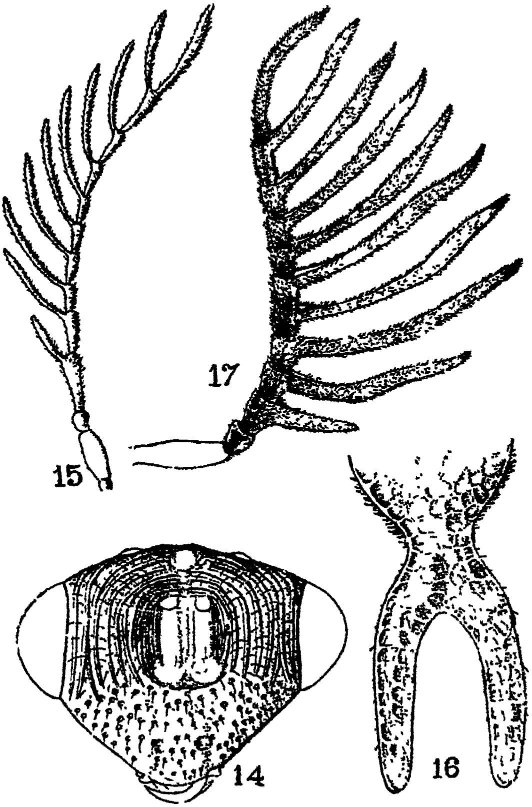
Body mostly dark mettallic green, antennae with 9 branches, the branches not exceedingly flattened, first segment of funicle simple: scutellum with the median furrow not very deep, processes relatively one-fifth shorter. without an abnormally broad carina; striae on face descending down to lower level of eye well on the attachment of antennae.. *K. travancorensis*, sp. nov.

Body metallic greenish-black; antennae with 9 branches. the branches rather greatly flattened, first segment of funicle with a short, stout branch, some of the other funicular segments with a supplementary short branch; scuttellum with median furrow rather deep, processes relatively longer with broad carinae; striae on face well above the level of attachment of antennae and never descending below......... .. ..*K. andamanensis*, sp. nov.

Family *MISCOGASTERIDAE*

Systasis dalbergiae, sp. nov.

Female.—1·6 mm. long. Bright metallic green. Head viewed in front (fig. 19) broadly rounded, interorbital space, height of head and width of head in the ratio of 21 : 28 : 35; lateral ocellocular space about one and one-fourth



Figs. 14-16—*Kapaloides travancorensis*, sp. nov. 14. head viewed in front; 15. antenna; 16. scutellar forks viewed above. Fig. 17. antenna of *Kapaloides andamanesis*, sp. nov.

the ocellar diameter when viewed from above. Mandible tridentate, face rugosely punctate between scape and inner orbital border, just below insertion of antennae transversely reticulate. Antennae: scape dark brown ventrad and almost black dorso-apically, rest of antennae very dark brown, other characters as shown in figure 18, inserted a little above the lower borders of eyes. Wing as in figure 20. Coxae, fore and hing femora concolourous with body, rest of legs yellow, except the paler hind tarsi.

Male.—Legs pale yellow, except the dark tips of tarsi and metallic hind femora.

Holotype one female on a slide, allotype one male on card, paratypes on cards. Received from the Forest Entomologist, Dehra Dun, labelled: Parasitic on larva of *Contarinia dalbergiae* Mani, infesting flower buds of *Dalbergia sissoo*, Dehra Dun, P. N. Chatterjee, 30. iii. 1938, 15. iv. 1941.

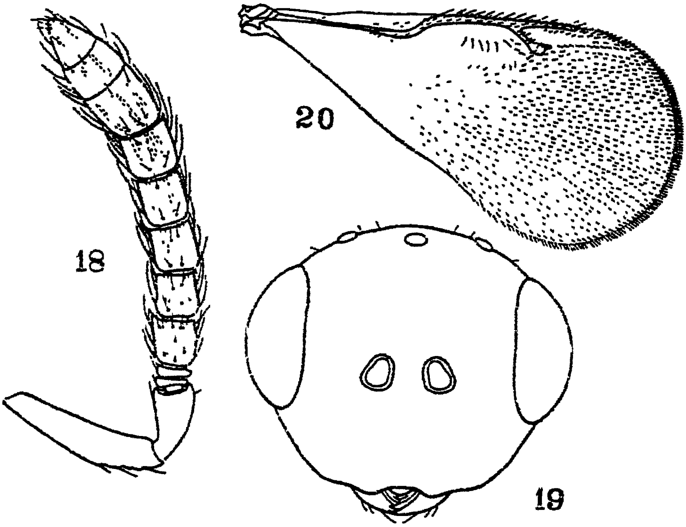
Family *EULOPHIDAE*

Tetrastichus xanthomelaenae (Rondani)

1870. *Oomyzus gallerucae*, Rondani. *Bull. Com. agr. Padova*, p. 5 (preoc.).
1872. *Oomyzus xanthomelaenae*, Rondani. *Boll. Soc. ent. ital.*, p. 73 (nom. nov.).
1905. *Tetrastichus xanthomelaenae*, Marchal. *Bull. Soc. ent. France*, p. 82.

I provisionally refer to this species a number of specimens in the Imperial Pusa Collection labelled: Bred from the eggs of *Galerucella singhara*, Delhi, M. Bose, 18 iv. 1942.

The species was originally described from Italy as parasitic in the eggs of *Galerucella luteola* and is being recorded here for the first time from India.



Figs. 18-20—*Systasis dalbergiae*, sp. nov. 18. antennae of female; 19. head viewed in front; 20. wing.

Silvestri[1] describes the species as below : "Femmina corpo di color verde molto scuro, lucente, cogli occhi rosso-scuri, le antenne giallo-scure grigiastre, le zampe giallastre coi femori bruno-neri eccetto che all' ertremità. L'ultimo articolo del tarso è pure alle volte di color bruno. Le ali sono traspatenti colla nervatura grigio azzurrognola. Lunghezza del corpo mm 0 65 0 75. Maschio : Differesce della femmina per le proportioni minori, le antenne diversimente conformate, per l'addome più ristretto del torace, per le zampe un poco più allungate, coi femori posteriori del colore delle tibie" He has also briefly described the egg and larval stages. The species is widelv distribued in France and Italy and was introduced into the United States of America by Howard in 1907 but failed to get establish itself there[2]

The adults feed on the juice of the host eggs which are punctured for oviposition The parasite develops for about 10-12 days in the host eggs and emerges as adult.

Family *MYMARIDAE*

Subfamily GONATOCERINAE

Tribe Gonatocerini

Alaptus ramakrishnai, sp. nov.

Male.—0.25 mm long. Dark brown. Head viewed from above subpyriform, ocelli in a wide obtuse angle, interocellar space twice the ocellocular, the later also about twice the ocellar diameter. Antennae as in figure 21, scape

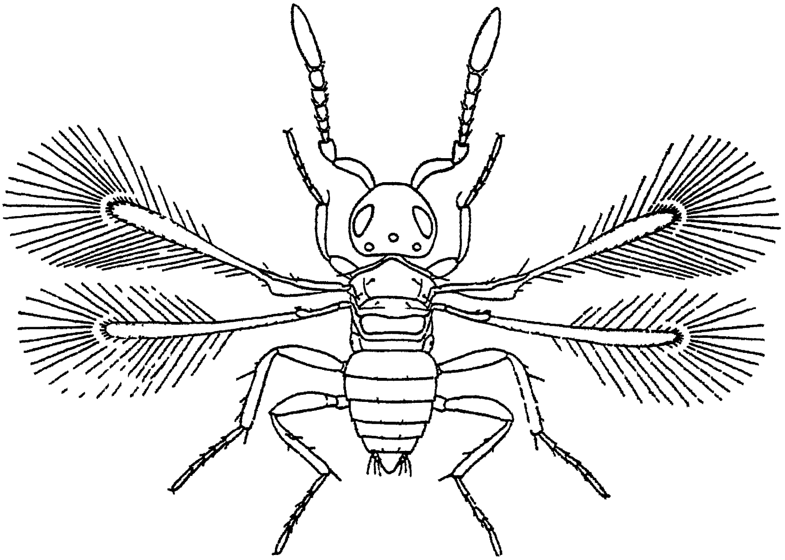


FIG. 21.—*Alaptus ramakrishnai*, sp nov.

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[1] Silvestri, *Ann. R. Scuola sup. Agr. Portici*, p. 29.

[2] The species was more fully redescribed by Masi in *Boll. Lab. Zool., Agr. Portici*, 1908: 48—50.

equal to the first four funicular segments combined, club equal to the combined length of the preceding four funicular segments, pedicel equal to the first two segments of funicle.

Holotype one male on a slide. T. V. Ramakrishna Ayyar, parasitic on mealy-bug on cocoanut, Coimbatore, i-xii-1934.

Alaptus delhiensis, sp. nov.

Female.—0.25 mm long. Dark brown. Viewed from above head length half the width. Ocellocular space twice the ocellar diameter and interocellar space two and a half times the ocellocular. Antennal pedical about half the scape. Club relatively more stout than in *Alaptus ramakrishnai*, equal to the funicle in length. Otherwise as in figure 22.

Holotype one female on a slide. On glass window pane in the laboratory of the Imperial Entomologist, New Delhi, M. S. Mani, 23.ix.1940.

Key to species

Pedical equal to the combined length of first two funicular segments, club equal to the combined length of the four preceding segments.........*A. ramakrishnai*, sp. nov.
Pedical shorter, club equal to the funicle..........................*A. delhiensis*, sp. nov.

Subfamily MYMARINAE

Mymar indica, sp. nov.

Male.—0.8 mm long. Brown. Antennae about twice the length of body,. segments 13, scape and pedicel brown, rest of antennae very dark brown, pedicel about one-third the first funicular segment and somewhat more than one-fourth the length of scape. Ocellocular space is equal to the distance between the lateral ocelli and front ocelli, interlateralocellar space one and two-thirds of ocellocular. Fore wings as in figure 23. Length of abdomimal petiole twice

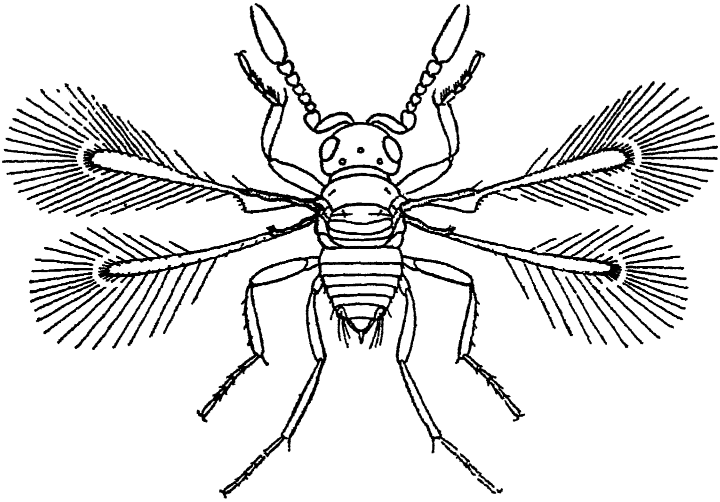

Fig. 22.—*Alaptus delhiensis*, sp. nov.

its diameter. The forked apical spur of fore legs and the pectinate setation of fore metatarsus as separately shown in figure 23.

Holotype one male on a slide Found along with thrips collected in dandelion flowers, Shumsher Singh, Delhi, 12.x.1940.

The genus *Mymar* is being recorded here for the first time from India.

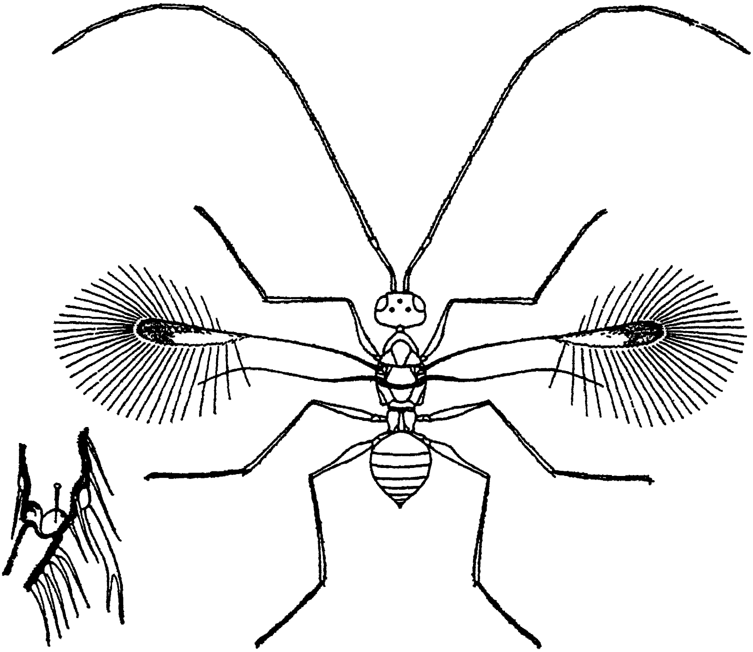

Fig. 23.—*Mymar indica*, sp. nov.

Superfamily BETHYLOIDEA

Family *ANTEONIDAE*

Subfamily GONATOPIDINAE

Pseudogonatopus pyrillae, sp. nov.

Female.—Length 3.5 mm. Dark reddish-brown, with extremely scattered, fine setae. Head : Darker above than below. Viewed above about twice as long medially; conspicuously excavated; interorbital space in front nearly two-thirds that behind, *i.e.*, median orbital borders diverge strongly behind, also slightly sinuate; orbito-occipital space about one-third orbital length; ocelli very close to each other in the middle of the deeply excavated vertex; vertex smooth, shiny or obscurely sculptured, in the ocellar area very finely striate, with very fine scattered setae; median longitudinal carina prominent and touching front ocellus; occipital area excavated. Viewed in front transverse, finely lederartig; frons yellowish by median orbital border; median longitudinal carina faint below, more prominent above and continued into vertex; clypeus obscurely finely lederartig, nearly twice as wide as long. Gena smooth. Mandible: yellow, 4-dentate, teeth dark brown, apical tooth largest, blunt; second smaller, acute; third and fourth smaller, blunt. Antenna about five sixths the length of body; scape yellowish-brown, ventrally yellowish, compressed, finely densely pubescent; pedicel about four-fifths of scape; third segment fully thrice the scape; rest of antenna paler.

Thorax without erect hairs; very distinctly divided; transverse carinae prominent; finely lederartig in front; smooth, glossy behind; narrowed part lederartig, 1½ times as long as broad, with a small, shiny area behind; propodeum finely lederartig in front and finely transversely striate behind, with a median longitudinal impressed line; about 1½ times as long as broad and five times as wide as narrowed part of thorax. Pleura matt.

Legs: F coxa about 3/4 the trochanter; F femora equal to F tibia; tarsal terminal pincer claw of the usual structure, with eight lamellae and a minute sub-apical tooth on the lateral process; ten close-set lamellae on the inner process; tarsi pale brown. H femur dark brown at the clavate base, rest of H legs light brown.

Abdomen: Black, smooth, shiny, with transverse rows of fine short setae in the middle of each tergite; petiole black, shiny about half the H coxae.

Male:—Length 2.5 mm. Head: Viewed above transverse; occipital margin strongly curved; more than twice as wide as long; interorbital space 2/3 the head width; occipito-orbital space 2/5th head length; interocellar space twice occellocular. Viewed in front sub-triangular, nearly twice as wide as long; median orbital borders slightly converging above. Gena 3/5th orbital length; posteriorly carinately raised. Frons medially, longitudinally raised; sculpture matt. Antennae dark brown, inserted opposite the lower orbital border. Scape ovate; pedicel slightly shorter than scape.

Thorax: Matt, coarsely lederartig; parapsidal furrows complete, distinct; scutellum distinct; matt; metanotum and propodeum matt.

Legs: Except the black coxae and the paler tarsi, fuscous-brown. Wings: hyaline; veins colourless; pterostigma colourless. Abdomen: nearly as long as thorax; smooth, shiny.

Holotype—One female on a card labelled: "P.C.S. 710. Parasite on nymph of *Pyrilla* spp. Karnal, K. Lakshmanan Coll. 7-x-1941". Allotype one male on card labelled "P.C S. 190, parasite on nymph of *Pyrilla* spp., Daurala Farm (Meerut). K. Lakshmanan Coll. 23-x-1938. Paratypes three females on cards.

DESCRIPTION OF TWO NEW AND REDESCRIPTION OF A THIRD SPECIES OF *APANTELES* (Braconidae) FROM INDIA.

By K. B. LAL, M.SC. (Alld), PH D. (Edin.),
Entomologist to Government, U. P., Cawnpore

The study, on which the present paper is based, was carried out while the author was Assistant Entomologist at the Imperial Agricultural Research Institute, New Delhi. His thanks are due to the Imperial Entomologist for his encouragement of the systematic study of parasites and for permission to avail of many facilities.

Apanteles balteatae sp. nov.

Male and female black. Antennae, ovipositor sheaths, all coxae, hind trochanters and apices of hind tibiae fusco-ferrugineous; rest of the legs, ovipositor, costal vein, stigma and metacarp testaceous; veins and tibial spurs stramineous.

Head: broad, easily three-fourths the distance between the tegulae; distance between hind ocelli slightly less than that between the ocellus and the eye on either side; very closely striate-punctate, occipital region smooth and shining with scarcely half a dozen fine punctures scattered about its entire area; sutures separating the first few flagellar segments not very distinct.

Thorax: mesonotum closely punctate with coarse punctures running laterally and posteriorly into sinuate striations; scutellum smooth and shining; propodeon with two oval areas demarcated near base by curved rows of punctation; striate, otherwise smooth, with no costulae, carina or areola, *Forewing:* length of stigma shorter than that of metacarp; first abscissa of radial as long as the breadth of stigma, its junction with the transverse cubital not clearly determinable, nearly twice the length of the transverse cubital, which, in turn, is about three-fourths the length of the recurrent. *Legs:* the longer hind tibial spur about half the length of the basal segment of the hind tarsus.

Abdomen: elongated oval, the greatest width being across the second segment from which posteriorly it forms nearly an equilateral triangle; first tergite rectangular with the lateral margins parallel, apical and basal widths equal and length twice of either, finely, though somewhat irregularly punctate across the middle third; second tergite twice as long as any of the following segments; all segments from the second with a transverse row of scattered pubescence along their posterior margins; ovipositor about as long as the abdomen.

Holotype (male) and allotype reared from the caterpillars of *Sylepta balteata* Fabr. by Huq at Pusa, Bihar. Paratypes, four female and one male, reared from the same host and locality. All specimens deposited in the Imperial Pusa Collection, New Delhi.

This species runs to couplet 53 in Wilkinson's (1928) key and in view of the apex and base of the first abdominal tergite being of equal breadth, might be considered to be close to *A. hyblaeae* Wilk. This, however, is not the case and the present species and *hyblaeae* differ markedly in many features, *e g.*, in the absence of areola in the former and in any evidence of the thickening of any part of the radial or transverse cubital veins, in the location and degree of punctation and in the colouration of the various parts of the body, etc. A. *balteatae* resembles *A. pusaensis* in several respects, *e.g.*, in the absence of areola, costulae and carina, in the general shape of the thorax and its punctation, in the long ovipositor, etc.

Apanteles pusaensis sp. nov.

Male and female black. Antennae dark ferrugino-testaceous; legs testaceous except all coxae and trochanters, hind femora, apical third of hind tibiae and portions of hind tarsi which are red testaceous to dark; mouth parts, tegulae, stigma, veins and tibial spurs stramineous, the costal margin deeper in colour; basal one-fifth of the abdominal tergite and ovipositor ferrugineous; ovipositor sheaths nearly black.

Female.—Head : finely and closely punctate between the ocelli and the scapes, round the ocelli the punctation neither fine nor close but appearing to be replaced by curved transverse striations; occipital region impunctate; hind ocelli about equidistant from each other and the eyes.

Thorax : mesonotum with very close and coarse punctation; disc of scutellum impunctate, shining and covered with small silvery hairs arranged obliquely; propodeon hardly half as long as broad, shortest length along the median line; mid-anterior margin slightly notched; punctate in basal half with some silvery pubescence along lateral margins; a very faint indication of areola noticed only in some specimens; costulae and carina entirely absent. *Forewing:* stigma nearly equal to metacarp; first abscissa of radial not sharply marked from the transverse cubital than which it is slightly longer and at least as long as the breadth of the stigma. *Legs:* hind coxae sparsely pubescent, otherwise smooth; the large hind tibial spur half as long as the basal hind tarsal segment.

Abdomen: first tergite narrower at apex than at base; nearly three times as long as broad in middle, sides sub-parallel, sparsely punctate about the middle region and sometimes towards the base also, thereby enclosing a smooth, irregular, quadrate area; second and succeeding tergites narrow; ovipositor sheaths about one and a quarter times longer than the hind tibiae,

Holotype (female) and allotype reared from the caterpillars of *Sylepta lunalis* Guen. by Huq at Pusa, Bihar. Paratypes, ten females and three males; also reared at Pusa from the same host. Cocoons white and in mass of about fifteen. All specimens deposited in the Imperial Pusa Collection, New Delhi.

The present species runs with difficulty to couplet 53 in Wilkinson's (1928) key and in some respects comes close to *A. calycinae* Wilk., *e.g.*, in the first tergite being definitely narrower at apex than at base and in the hind femora being red testaceous. It differs, however, from *calycinae* in the absence of an areola, in the degree of mesonotal punctation, in the absence of any sculpturing on the first abdominal tergite, etc.

Two species of *Apanteles*, *A. syleptae* Ferr. and *A. sagax* Wilk. are recorded to have been reared from *Sylepta derogata* Fabr., another species of the genus to which the hosts of the two species, now described, belong. As remarked by

Wilkinson (1929), *A. sagax* and *A. syleptae* are themselves very different from each other and it seems that the present species can be closely related to neither *sagax* nor *syleptae.*

Apanteles chilocida Viereck.

Female black; tegulae and legs testaceous, except hind coxae (up to apices), apices of hind femora and tibiae and hind tarsi, which are black and fore and middle tarsi which are slightly darkened; bases of scape, stigma, costal border and metacarp ferrugino-testaceous, veins lighter; eyes violet to testaceous; tibial spur white.

Male agrees with the female except that the abdominal ventrites are a light testaceous, gradually darkening towards the apical half; the third abdominal tergite has a ferrugineous sheen (in some specimens) and the eyes are black.

Female.—Head; viewed sideways unusually prominent below antennae; hind ocelli equidistant from each other and from the eyes; finely but sparsely punctate; occipital region smooth and shining; eyes rather small.

Thorax: as wide as the head at its broadest; punctation on mesonotum, mesopleurae and disc of scutellum rather coarse but close (in apical half of mesonotum punctate and striate); ventrites anterior to the middle coxae thickly covered with well marked longitudinal, silvery striae on either side of the median line and merging anteriorly into equally well marked, coarse punctation, propodeon about half as long in middle as wide, anterior margin sharply defined, specially on either corners, concave, well but rather irregularly punctate. *Forewing*: stigma slightly shorter than metacarp; first abscissa of radial vein slightly curved and equal to the width of the stigma, also to the length of the transverse cubital or of the recurrent. *Legs*: smooth and shining except that the coxae are aciculate-punctate; basal joint of hind tarsus two and a half times as long as the segment following; both the hind tibial spurs about equal and each is about half the length of the basal segment of the hind tarsus; a small triangular area in the metapleural region remarkably smooth and shining.

Abdomen: as long as thorax; sharply elongated oval; first tergite very much like that of *A. flavipes* Cam.; one and a quarter times as long as broad at base; nearly twice as broad at apex as at base; aciculate-punctate except over a roundish area at base and a narrow strip along posterior margin; second tergite about as long as the third, punctate-striate (longitudinally); fourth and subsequent tergites of nearly but not quite equal length (about three-fourths the length of third) and smooth; ovipositor very short and hardly exerted.

Male agrees with the female except that the punctation all along is closer and thicker in the former.

Redescription· drawn up from two male and a dozen female specimens reared from the larvae of *Perigea capensis* at Nagpur by K.B S. and at Seoni, Central Provinces. Two specimens, reared in Burma on 11-7-39, have also been identified as belonging to *A. chilocida.* All the specimens have been deposited in the Imperial Pusa Collection, New Delhi The species was first described by Viereck (1922) as *Apanteles* (*Stenopleura*) *chilocida.* The type locality was stated to be Japan and the host "*Chilo simplex*".

This species is being recorded for the first time from the Indian region and seems to parasitise more than one species of moth larvae. It is hoped that the redescription, now presented, will help in its easy recognition. It comes very close to *A. flavipes* Cam. and *A. sesamiae* Cam.; in the matter of mesonotal punctation it comes nearer to the latter than the former. The distinctive features of *A. chilocida* are, 1. the black colour of the hind and the aciculated punctate condition of all coxae, 2. the darkened tips of the hind femora and tibiae, which are very marked and 3. the prominence of the face below the eyes. Viereck (*op. cit.*) has mentioned that the wings have a brownish tinge, which I have not noticed in the specimens before me and that the third abdominal tergite is brownish. In one or two specimens I have observed a ferrugineous sheen on the third abdominal tergite but not in others. It is possible that this is a varietal character.

REFERENCES.

1 Viereck, H L., 1912, *Proc. U.S. nat. Mus.*, **43** : 582

2. Wilkinson, D S., 1928, *Bull. ent. Res.*, **19** (2) : 141.

3. Wilkinson, D S., 1929, *Bull. ent. Res.*, **20** (1) : 112.

INSECTS ASSOCIATED WITH THE LOTUS PLANT IN PENINSULAR INDIA.

By T. V. Ramakrishna Ayyar, B.A., Ph.D.

As far as the writer is aware there are no accounts of insects associated with this well known and famous member of the vegetable kingdom, excepting a solitary record by Das of a species of *Aphis* from the Punjab. A record of a pyralid (*Nephopteryx semirubella Scop.*) on *Lotus* is given by Hampson but with no locality or any other information (*F. B. India*). Apart from its fame in the oriental region—as the bearer of the flower which is recognised as an emblem, standard and ideal of beauty, it is perhaps not well known that the lotus plant has its economic value also. While in most parts of India the fame and superiority of the flower for use in religious functions is considered second to that of no other flower, the leaves and the main roots of the plant are also used for various purposes. The smooth and velvety circular leaves are not only used for packing fresh flowers and cooked eatables, but are actually used as eating plates in Indian households, in the same manner as banana or other leaves. The ivory coloured main roots of the plant are made into different preparations as eatables—some of them being very delicious. The fruits are also used for medicinal purpose in different parts of India. As such both from the economic and the aesthetic points of view the plant has its fame and importance. The writer has been noting some insects and their ways on this plant during the past two years in the Malabar District in South India and in the Deccan and the following summary of the observations so far made might be of some interest to Indian entomologists—especially those engaged in economic work since there is nothing on the subject published so far. The following five insects have been noted on the plant till now.

1. *LOTUS HAIRY CATERPILLAR* (*Simyra conspersa Moore?*) This is a fairly stout dark brown caterpillar having the body fringed with dark gray hairs rising from tubercles. The adult is a medium sized stout moth with whitish wings and body. The main features in the life history are as below. *Eggs*: The small flattish oval eggs are laid in groups of hundred or more in patches on the leaf surface. The eggs are flattish, oval and are arranged in overlapping parallel rows like scales; the egg surface is finely and beautifully sculptured like that of some marine bivalve shells. When fresh laid the egg mass is golden yellow but gradually it turns bluish brown. More than two hundred eggs have been found in one batch. The eggs hatch in from four to five days in captivity. *The Caterpillar*: The just hatched larva is 1.5 mm long with the body having a dark greyish colour and fringed with hairs. The head and anal segment are black while the body shows transverse rows of hair-bearing tubercles; but these become conspicuous only as the creature grows. The ventral side is pale grey. In 2 or 3 days the caterpillar gets a pale greenish white tinge and has 4 or 5 distinct violent brown patches on the dorsal surface at intervals. One on prothorax; one each on I and 2 abdominal segments, one between 4th and 5th segments and one just before the anal segment. The head and the segmental tubercles are black as also the hairs; the legs are dark. Even at this stage the creature is able to distribute itself by means of silk threads. The larva at first feeds by scraping the green epidermal layer of the leaf and as the caterpillars

grow they skeletonise the leaves leaving only the radiating ribs attached to the stalk. When full fed the caterpillar is 30-35 mm. long with a fairly cylindrical and elongated body. The general colour at this stage becomes brighter and though the ground colour is greyish it gets markings of white, yellow and brownish all over the surface. The head has a net work of pale yellowish markings on a grey ground color. There appears a latero-ventral yellow longitudinal streak on either side of the body along the region of the spiracles. The body surface is covered with hair bearing tubercles; each segment has a transverse row of about 8 flashy tubercles each bearing a number of setae and hairs The median dorsal area is darker, with numerous pale white markings on each segment; some of the tubercles on the dorsal area bear black setae and the bases of some of them have a reddish brown tinge. The prolegs are brownish green inwards but darker along the outer area. Legs are dark. The spiracles are clearly seen as whitish spots just above the latero-ventral yellowish band. Though the body is hairy, the hairs do not appear to be irritating to the touch. The caterpillars feed gregariously almost upto the pupation period and cause appreciable damage to the foliage. The larval period occupies about three weeks. *Pupa:* The caterpillars pupate on the margins of the leaf itself; the brownish red pupa is enclosed in a tough whitish cocoon of very fine pure silk unmixed with hairs, and this is covered over by a folding of the leaf. The pupa is 15-18 mm. long with the cremaster having two or three very short blunt spine like structures and a few small gold coloured cilia. The pupation period generally occupies from 8 or 9 to 12 days. One life cycle roughly occupies 5 to 6 weeks.

Moth:—The adult insect as stated at the beginning is a medium sized, stout whitish moth. The head, thorax and upper wings are greyish straw coloured, while the lower wings, abdomen and the ventral region are of brighter uniform white colour. The upper wings have faint fuscous streaks towards the apical margin, and the front margin is narrowly straw coloured. The moths have an average wing expense of 40-45 mm. No striking differences in colour are noticed between the sexes.

Specimens of this moth which appeared quite unfamiliar to the writer were sent to the Imperial Entomologist Delhi who kindly examined the same and was of the opinion that it may be *Simyra conspersa* Mo., but was not quite sure of the same. While this name is not found in Hampson's fauna volume there is a record of *Nonagria conspersa* Mo., which appears to the writer to be the same as *S. conspersa.* The Forest Entomologist who kindly examined specimens is also not quite sure of this identification of the lotus moth. Until the insect is correctly identified from further good material which the writer is arranging to procure we may retain this provisional identification. Any way there is no past record of this moth as having been reared out on any plant as far as the writer is aware. No alternate food plants of the insect have yet been noted.

Natural enemies: The caterpillar has been found to be subject to the attacks of two natural enemies. One is a small Braconid (Apanteles sp); each

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Note:—Since writing this, the writer's attention has been kindly directed by the Forest Entomologist Dehra Dun to Hampson's later work *Lepidoptera Phalaenae* where *Nonagria conspersa* and *Simyra conspersa* are stated to be synonymous, thus confirming my suggestion and in addition to Calcutta the insect has been recorded also from the Punjab, Mainpuri, Sikkim and Raipur C.P. (T.V.R.)

parasitised caterpillar is often found covered with hundreds of the small whitish cocoons of this wasp and numerous such heavily parasitised caterpillars are noticed in the July—August brood. The other is the red and black coloured ichneumonid wasp *Melcha nursei C.* which has been noted as a parasite of many other caterpillar pests in different parts of India

This hairy caterpillar has so far been noted on lotus in the lakes and water channels near about the city of Hyderabad (Deccan) and has not been found on any other plant till now. Observations so far made indicate that the pest passes through at least two generations on lotus from early June to end of August. It has not been found on this plant during the cold weather.

2 *THE TOBACCO CATERPILLAR (Prodenia litura F. Noctuid.)*:— This is a notorious insect pest which is found in various parts of India. It has so far been recorded on about two dozen or more plants and some of them like tobacco, castor, sesbania etc. often suffer very seriously from its attack; but so for the writer has not found it recorded on lotus though he has noticed it on this plant both in Hyderabad and in South Malabar. As is the habit with this insect the caterpillars feed gregariously and cause the same kind of injury to the foliage as the hairy caterpillar One important difference is, that, while the latter pupates inside a lotus leaf fold itself, the tobacco caterpillar generally leaves the leaf and seeks the soil along the shores of the pond. To adapt themselves for this purpose the caterpillars confine themselves to those lotus leaves which are nearer the shore. In South India the pest was noted to be particularly bad when the water in the pond dries up almost completely and the lotus vines pass the summer only with the help of the moisture of the mud in the pond.

3. *THE AQUATIC CATERPILLAR (Nymphula sp ? Pyralid)*: This is a slender pale green caterpillar found along the edges of the lotus leaf more or less touching the water surface. Infested leaves show numerous folds on the leaf margins and inside each fold a caterpillar is found feeding on the leaf tissue. The caterpillar is a typical aquatic larva with gill structures for breathing which enable the creature to remain on the watery surface The full grown caterpillar is 6 to 7 mm. long The pupa is found in a small tubular water proof case made of leaf tissue and silk and this is attached to the upper surface of the leaf. The adult is a small white delicate moth more or less resembling the moth of the well known case worm caterpillar of Rice (*Nymphula depunctalis Guen*). The body and wings have a silvery grey colour with light yellowish marks and clear white wing cilia. Two varieties of this moth have been reared out by the writer; one appears to be *Nymphula affinalis* and another, which more or less agrees with the description of *N. crissonalis W.* in Hampson. The writer has noted species of *Nymphula* previously on aquatic creepers of sorts in tanks and ponds in Malabar where very often the plants are completely defoliated by the caterpillars during certain seasons and numerous moths are found flying about over the water surface. Very evidently more than one species of *Nymphula* affect these aquatic plants.

4 *THE LOTUS THRIPS* (*Scirtothrips dorsalis H* var new *padmae*): Thousands of a minute pale yellow species of thrips are often found on the tender leaves and the flower buds. On the leaves the creatures generally confine their attentions to the succulent regions near the leaf stalks; attacked portions present a pale sickly appearance. The insect is a very minute creature with a pale uniform yellowish colour This thrips appears to be a *Scirtothrips* and very closely allied to *S. dorsalis* described by Hood in 1915 from material collec-

ted by the writer on Chillies in S. India. Though the colouration of the antennae and the wing structure show some differences they do not appear to the writer to be sufficient to give the insect the rank of a new species until closer studies are made. It may therefore be regarded as a variety of *dorsalis* and I have given it the name *padmae* after the lotus plant.

5. *THE LOTUS APHIS* (*Siphocoryne nymphaeae L.*). Colonies of this aphis are found on the lotus foliage in company with the thrips, especially on the succulent regions of the plant near the leaf stalks, tender leaf buds etc. These appear to cause comparatively greater damage to the foliage than the thrips; the whole leaf surface becomes sickly and very pale The material of this insect was kindly identified for the writer by the Imperial Entomologist. This aphis has been previously recorded by B. Das, 1918, *Mem. Indian. Mus.*, **6** (4): 191, as collected on the aquatic plants *Lotus*, *Scripus*, and *Lemna*. The insect popularly called "The water lily aphid" has a dark olive green colour and is said to be commonly found on numerous aquatic plants in various parts of the world. A few lady-bird beetles have been noted predatory on the plant lice but sufficient material has not yet been found.

Further observations are being made on the insect fauna of lotus in different areas and it may perhaps be possible to add more to our knowledge on this subject in due course.

A NETTLE GRUB PEST OF THE BANANA PLANT IN SOUTH INDIA

(*Miresa decedens* Wlk.)

By T. V. RAMAKRISHNA AYYAR, B A., PH.D.

Among the foothills and valleys bordering on the slopes of the Western Ghats along the Malabar Coast, which receive a copious supply of rainfall every year, the banana plant is grown as a perennial crop around every household and in all gardens. So far, this plant has not been found to suffer seriously from any insect pests, though some forms have been noted on it now and then. In Malabar as far as the writer knows these few are the stem borer beetle (*Cosmopolites sordidus Germ*), a notorious banana pest in tropical areas, the leaf caterpillar (*Prodenia litura Fb.*), a lace wing bug (*Stephanitis typicus Dist.*) and a thrips (*Heliothrips kadaliphilla Ramk.*); and one or two of these have been occasionally noted as sporadic local pests. In July 1940 in his banana plantation situated in the south eastern border of the Malabar District close to the western ghats, the writer noted a caterpillar pest which appeared to be not only a new record for the banana crop but even as a form not noted before as a crop pest anywhere. Though it was at first thought to be the Castor slug *Parasa lepida Cram*, which appears occasionally on banana, on closer examination it was found to be quite different from the latter. Finding it to be something new the writer attempted to make some observations on the bionomics of the insect and the following summary of the same, however imperfect, is presented with the idea that it may add a little to our knowledge of south Indian insects, and particularly of those associated with the banana plant.

The first indication of the existence of the insect was the appearance in July 1940 of large and small irregular holes on the surface of the leaves of numerous plants seven to eight months old. Though on first examination it was possible to recognise the injury caused as the work of a leaf eating creature, the pest was not easily traced; on closer examination however it was found that the culprits were hiding in the grooves between the plant stem and the succulent leaf stalks, obviously indicating that the creature feeds during the night and remains hidden during day. The insect is a species of nettle grub (Family *Limacodidae*) and appears to be quite different from any of the family so far known to the writer as pests The caterpillar is a typical nettle grub with a short, stout and very fleshy body, covered with rows of fleshy tubercles bearing irritating and poisonous spines. On casual observations the caterpillar is likely to be mistaken for the castor slug *'Paraşa lepida'* a well known pest of castor, mango, wood-apple and occasionally of banana also—but as stated above, it was found to be an entirely different insect. When full grown it reaches only one inch in length. The head is small and dark and covered over by the fleshy prothoracic region. The general colour of the body is pale greenish white, with a distinct broad median dorsal bluish black longitudinal band running from the thorax to the anal segment covering whole of the median dorsal area. The ventral region is of a paler hue. On the body there are four longitudinal rows of spine bearing tubercles, one row along each side of the middorsal dark band and another along each latero-ventral margin: the tubercles are profusely supplied with spines of different sizes. The tubercles of the two latero-ventral rows are more conspicuous and each of them has a brownish pad like structure in the centre, very irritating to the touch. The tubercles of the two dorsolateral rows situated in the thoracic segments are much longer than any of the other tubercles of the body and are very conspicuous, bearing numerous spines of different sizes. These and the spines of the anal tubercles have a shining yellowish tinge. The caterpillar even in captivity is not found to feed exposed.

The full grown larva pupates inside a hard stout egg like spherical cocoon of a dirty brown colour as usual with most of the nettle grubs The cocoons of the caterpillar are generally found attached to the extreme lower regions of the banana plant, often under the soil in such a way that even when the plant is cut the pupae escape danger, being attached sufficiently lower down the stem. The insect has been found to remain in the pupal stage from September-October to June-July, of the following year; from cocoons kept in captivity in September, 1940, the writer got moths emerging only by the end of the following June the pupal period thus occupying from 8 to 9 months, and the insect evidently passing through only one generation in the year The insect was noted during this year also (June 1942) though not on such a large scale as in the previous two years.

The adult is a short stout moth; though the general colour is a greyish brown, there is a golden velvety bloom all over the dorsal surface; when the moth rests, the golden bloom on the prothorax is very conspicuous. The wings are pale greyish and do not cover the whole abdomen; each upper wing has a light very pale transparent cross streak; the legs are stout and hairy.

The insect which belongs to the moth family *Limacodidae* has been kindly identified by the Forest Entomologist Dehra Dun as *Miresa decedens Wlk;* and the writer is obliged to him for the kindness. The descriptions of the larvae of two other species of Miresa (*M. albipuncta* Herr. and *M. argentifera* Wlk) given in Hampson's Fauna of India volume do not agree with the larval characters of the insect noted in this paper.

Among Indian forms of the family *Limacodidae* we have so far only a few species recorded as having any economic importance. These include the well known and fairly well distributed species *Parasa lepida Cr.* which attacks castor, mango, coconut, wood-apple and other plants, *Contheyla rotunda Hmp* noted as a pest of tea and the coconut palm in Malabar, *Natada nararia Mo,* noted as a pest of the coconut palm in parts of South India, *Altha nivea* found as minor pest of castor in South India and species of *Thosea* & *Belippa* noted as pests of Tea in Assam and South Indian hill areas. The insect described in this paper is therefore a new addition to the nettle grub pests so far recorded on cultivated crops in India.

STRUCTURE, FUNCTION, AND ORIGIN OF THE EXUDATE ORGANS IN THE ABDOMEN OF THE PHYSOGASTRIC QUEEN OF THE TERMITE *TERMES REDEMANNI* WASMANN.

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(*With 3 Plates, 14 figs. and 1-6 Text figures.*)

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INTRODUCTION

In social insects exudates from the body are taken in as food and play an important role in the economy of social life in as much as they are exchanged between different members of a colony. Exudation in giving rise to trophallaxis (Wheeler, 1928), thus becomes an important factor in evolution of social habits.

In a termite colony of the mound-building species, the chief interest centres round the physogastric queen which gives out copious secretions or exudates from the surface of her voluminous abdomen. The latter is eagerly licked by soldier and worker castes who tend her and feed her with stomodeal food (Escherich, 1911).

Holmgren (1909) regards that more the queen is fed by her attendants, the more exudates she gives out from the abdominal wall, and the one influences the other so as to cause by giving rise to excessive nutrition of the queen, the physogastry. He further explains that there is a quantitaive difference in exudation at the early stages among the different members of a termite colony and this in as much as it induces selective feeding and thereby inhibition of sex, influences the origin of the varied castes. Although this view of polymorphism is disputed by Snyder (1935), the influence of exudates of the queen on the constitution and development of a termite colony is admitted by most of the authors in view of distribution of exudates to various members by the grooming habit of the termites (Kofoid, 1934).

While the abdominal exudates from the queen have thus important bearing on the social structure of the termites, the nature of exudation, or rather the organs concerned in elaboration of these exudates, are but little understood and their morphology has not received adequate attention.

It may be noted that Holmgren (1909) was the first author to call attention to the definite existence of a special exudation tissue in the termite queen. This tissue, according to him, was a kind of gland situated within the abdomen, below the hypodermal layer of the bodywall, and it was composed of epithelial-like cells which resembled the fat cells but nonetheless differed from them in not containing any fat droplets. Its secretions were assumed to pass to the exterior through hollow trichomes or hairs distributed on the cuticle. This glandular tissue was considered to originate by the direct transformation of the fat cells. In other phases where such a special exudation tissue was lacking, the exudation was accounted for, by the dissolution of fat cells yielding a granular liquid which issued to the exterior through hollow hairs, or through pores in the cuticle as in the males where trichomes disappeared in course of development. However, Feytaud (1912) was opposed to the theory of formation of the special exudation tissue in the queen by the direct transformation of fat cells as shown by Holmgren. He stated that it was formed indirectly from the fat cells through the action of leucocytes which infiltrated into the latter. Bugnion and Popoff (1913) disbelieved in such a mode of formation of a glandular tissue like the exudate glands, from an epithelial-like tissue or, fat cells, through the agency of leucocytes, and discounted the existence of hollow trichomes or any other channels, for the passage of exudates to the external surface of the abdomen. What he observed in the mature queen of *Termes redemanni* Wasm., obtained from Ceylon, was the existence of a columnar tissue, akin to Holmgren's special exudation tissue, but this was penetrated by tracheal-like tubes which were condensed around each abdominal spiracle. Since he could not detect any duct or any communication of the columnar tissue with the exterior, he was of opinion that it was a gland derived from tracheal-gland cells, having an internal secretion which acted on the composition of blood. Now if the exudation could be in the nature of an internal secretion as assumed by the last author, liberation of this substance to the external surface of the abdomen as observable in nature, remains inexplicable.

In fact, the divergent views referred to above, create an uncertainty as to the morphology of the glandular system concerned in exudation. We have therefore, investigated in detail the exudate glands and associated structures in the abdomen of the mature or physogastric queen of *Termes redemanni* Wasm. which is commonly found in the vicinity of Calcutta. For elucidating the homology of the exudate glands, we have compared the integument, the glands, the fat cells and relevant structures of different castes at the early and mature stages. Special attention has been paid to the structure of the abdominal wall in the queen as the latter presents an exuding surface which is licked by worker and soldier castes. We have also discussed the significance of the exudate organs in relation to social habit of the species. The biology of the species for convenience, has been referred briefly under the heading Material, so as to facilitate discussion at the end of this paper. In indicating the bearing of exudation on the physogastry of the queen, we have made an attempt to explain an aspect of the post-adult growth of the female, not touched by the previous authors.

Our observations differ in many essential points from those of previous authors particularly in showing (*i*) the existence of (*a*) a superficial and (*b*) a deep exudation system in the abdomen of the *mature physogastric* queen. The superfical exudation system is comprised of secretory vesicles on the external surface of the abdominal wall, and the deep exudation system is made of exudate glands which correspond to the special exudation tissue of Holmgren or columnar tissue of Bugnion. (*ii*) direct communication of the deep exudate glands to the exterior, through tracheal-like ducts which open by separate apertures on the abdominal spiracles, *(iii)* dissolution of old tracheal and muscular connections, and secondary formation of abdominal spiracles in the dealated queen, (iv) derivation of the exudate glands from the hypodermal layer of the integument and not from the fat cells.

MATERIAL

The material was collected from Halisahar, nearly 30 miles distant from Calcutta. The place abounded in mounds of *Termes* (*Cyclotermes*) *obesus* (Ramb.) and *Termes* (*Odontotermes* ?) *redemanni* Wasm.

The latter species was selected, for our study as its mounds cropped up high above the level of the ground, offering better facilities for digging out the queen. Further since the same species occuring in Ceylon, was used by Bugnion in his anatomical studies, it offered us the advantage that any difference noted in the morphology, could not be argued as due to the difference in material. To obtain different stages of the species such as the larvae, nymphs with wing-pads, the males and the females, the mounds were dug in different seasons of the years 1937 and 1938, and the collections from the different nests were kept separate. It may be pointed out that the nymphs with wing-pads were found along with other stages only in the months of March and April, while the developing eggs and all the stages or castes except the sexual alate forms, are met in the same nest throughout the year. Since searching out of the physogastric queen meant demolishing of a large portion of the nest and the colony did not thrive well after the removal of the queen, specimens representing the various phases were often obtained from more than one nest.

The physogastric queen along with a dealated sexually mature male or the king, is usually found within the mound enclosed in a narrow earthen cell called the royal chamber which is slightly larger than the body of the queen. Occasionall two or more queens of the same size occur in the same chamber as referred to by Hegh (1922), but their heads were found turned in opposite directions possibly to facilitate exchange of proctodeal food. A very large number of workers and soldiers are seen inside the chamber tending the queen. The king or the dealated male, is small and in our collection measures 14 mm. in length, but unlike the queen it is active in habits and generally escapes as soon as the royal chamber is opened. In both sexes the antennae and legs are found broken.

It is worth pointing out that the royal chamber in the mound is far away from the upper or laterally placed chambers which contain combs known as the fungus gardens that are used for cultivation of white spheres eaten by soldiers and workers. They also serve as nurseries since the larvae or immature forms, occur there along with the mature or adult soldiers and workers. The larvae seem to graze on a type of mycelium which covers like a soft felt the inside of the combs. Quite different from this type of combs or the fungus gardens there is another comb which is exceedingly moist and is dark brown in colour and papery in texture. It is of a different pattern from the rest and is the largest in size. It is located deep down in the centre of the mound. In this comb, eggs alone, but no larvae or other stages, are found. Close to this but quite separate from it, the royal chamber is situated. The royal chamber is walled up on all sides, but there are very narrow passages in it leading to other chambers for ingress and egress of soldiers and workers. No food of any kind is found stored in it.

Eggs as soon as they are emitted along with a discharge of a liquid by the queen, in streams, are transferred from the royal chamber to the central moist comb which serves as the egg depository or the incubator. The queen, so to say, remains a prisoner within her cell exclusively dependent on soldiers and workers for food supply and protection, and cannot escape from this cell. It was remarkable to note that in two nests dug during the rains, the royal chamber was found very near the top of the mound while in those opened during the dry season particularly in the hot months of the year, it was found either very deep underground near the level of the sub-soil waterline, or placed more towards the surface drainage adjoining the mound. This means that the royal chamber is not a permanent one and is shifted according to the exigencies of the season. The queen evidently is transported from the old one and a new one is built around her by her attendants. The mutilation of the limbs might occur during the transport.

The large queens in our collection, according to the estimation given by Escherich (1911) and Hegh (1922) should be several years old. The largest of the physogastric queen in our collection measures after preservation in alcohol, 80 mm. in length and the smallest 60 mm., allowing for the contraction during killing and fixation. Unfortunately we could not get any queen at the incipient stage of colony formation.

The immense size of the abdomen of the mature physogastric queen, is not owing to the mere distension of the wall or stretching of the intersegmental folds or membranes, as in the repletes of the ants, but due to continued growth and extension of ovaries, alimentary canal, and the bodywall, producing an all round increase in the size of the abdomen. This growth starts soon after the fecundated female has settled down after dealation, to found new colonies, and continues throughout the life of the queen. This post adult growth (Snyder, 1935) is of a unique kind because this comes in after the sexual maturity has been attained and no moulting is known to occur between these growth periods.

The live specimens after removal from the nests, were kept in glass jars or artificial nests, for observation of their behaviour. In our artificial nests the queen lived for a week when kept with a large number of workers and soldiers. The workers and soldiers crawled over the abdomen of the live queen, and were closely watched under a magnifying lens as they licked the exudates covering the bodywall of the queen. The small workers constantly fed the queen as well as other workers. The queen continuously laid eggs under the artificial conditions. But on her removal from the natural home, it died within a day or two if it was not accompanied by the worker and soldier castes. The latter invariably desert the dying queen whose body is shrivelled up.

METHOD

A mature physogastric queen in fresh condition was dissected in saline solution and its internal organs were examined. The dissected parts such as, spiracles, integument, and glands, were taken out and were prepared for microscopical studies. The entire abdomen of the queen as well as of the other stages were also serially cut by microtome and studied. Of the various fixatives tried, Carnoy and Lebrun's fluid gave the best results. The fixed material was as usual dehydrated in ethyl alcohol. But, curiously enough, we failed in the beginning to cut serial sections of the entire abdomen of the queen by the ordinary paraffin method or by the double embedding in paraffin and celloidin dissolved in clove oil, although the body was weakly chitinised and was not hard, and each constituent part if separately taken, was amenable to sectioning by the ordinary parffin method We succeeded, however, in making serial sections by avoiding the use of essential oils such as cedar wood or clove oil either as clearing agents or as solvents of celloidin. Neither xylol was used for clearing after dehydration. The dehydrated material from absolute alcohol was directly passed from thinner to thick solution of celloidin dissolved in absolute alcohol and ether; infiltration took two weeks under room temperature. The mass was solidified in chloroform and passed on to molten paraffin of lower melting point 52°-54°C. In case of sexually mature winged forms vacuum embedding bath was used for withdrawing air from the tracheae. In the case of soft bodied larvae, as well as the adult worker and soldier, ordinary method of embedding in paraffin of melting point 58°-60°C. served the purpose. Sections were cut 8-10μ thick. In the downgrade passage of sections, the slide, after removal of paraffin by xylol, was dipped for a moment in a thin solution of celloidin in alcohol and ether, and passed on to lower grades of alcohol, the object of the process being to prevent chitinous parts from floating away from the slide at the time of using aqueous stains (Mukerji, 1933). Various staining reagents were tried. Ehrlich's haematoxylin counter stained by eosin was found good for study of histological details while Mallory's triple stain was useful for differentiation of various tissues in the body. Eosin and acid fuchsin were readily taken up by the exudate glands and by the finer granular matrix in the haemocoele. Borax carmine followed by picro-indigo-carmine solution gave best results for nerve elements and fat cells, particularly in the immature forms.

Photomicrographs and camera lucida drawings of important organs were taken. To facilitate comparison of homologous structures such as the fat cells, or the integument of the different phases, the pictures of these were drawn or photographed under the same scale of magnification.

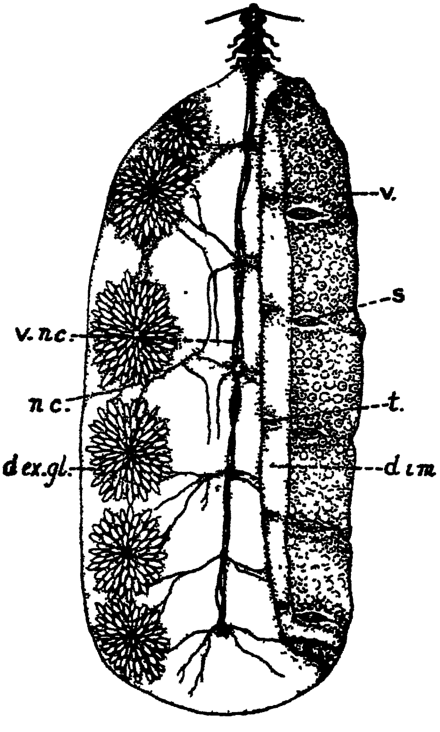
THE BODYWALL AND ITS SECRETORY VESICLES

External features :—The increase in size of the abdomen in the physogastric queen is accompanied by the growth and expansion of the intersegmental membranes, the abdominal tergites and sternites retaining the same size as in the alate forms; but these are widely spaced out. In a queen of approximately 8 cm. in length the abdomen is plump, the distance between the two consecutive tergites counting from the third to the eight varies from 8 mm. to 11 mm. In the alate sexual forms, however, it may be noted that the tergites are more closely spaced and the intersegmental membranes are soft narrow belts between the sclerites. In the alate forms, the tergites are similar in texture to those of the queen, shining and brown in colour. They are likewise strongly chitinised. Two transparent circular areas are found towards the lateral margins of each tergite in the anterior region of the body, simulating the spiracular apertures.

In both the alate and dealated phases, solid cuticular hairs occur in plenty on the tergites as well as, on the sternites. The sternites in the queen are flexible and less weakly chitinised than the tergites. These sclerites are laid flat and not arched as in the winged sexual form.

The intersegmental membrane on the dorsal and ventral aspects of the body in the physogastric queen (Text-fig. 1), is smooth and exceedingly thin as compared to that of the alate phase; it is white and transparent. In preserved specimens it is wrinkled. Solid cuticular hairs are sparsely distributed over it.

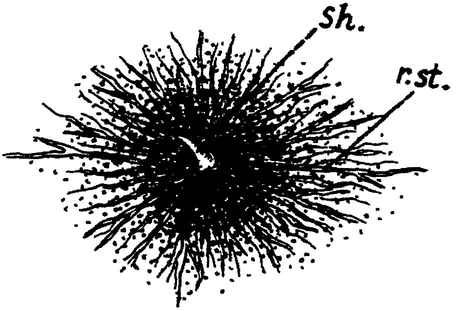
The lateral bodywall in the segmental zone as well as in the intersegmental zone is conspicuously thick, and stands in sharp contrast to the dorsal and ventral surfaces, in being thrown into undulating folds giving rise to the formation of crests and grooves. It presents a corrugated appearance, the grooves being smooth inside and non-pigmented. The crests are studded with numerous little protuberances which collect into numerous isolated groups. These represent secretory vesicles, which are dark brown in colour, (Text-fig 1, *v*) and comprise the superficial exudation system. The bodywall containing the vesicles is richly innervated by fibres arising in common with the spiracular branches from the ganglia of the ventral nerve cord. The distribution of the nerves is shown in the above figure.



TEXT-FIG. 1.

Diagrammatic representation of a dissected specimen to show the disposition of the exudate glands (*d. ex. gl*) and their ducts and the nerve supply (*n. c.*). The bodywall on the left removed but on the right retained to show spiracles (*s.*) vesicles (*v.*), dorsal intersegmental membrane (*d. im*), ventral nervecord (*v. nc.*) and tergites (*t.*). × 2.

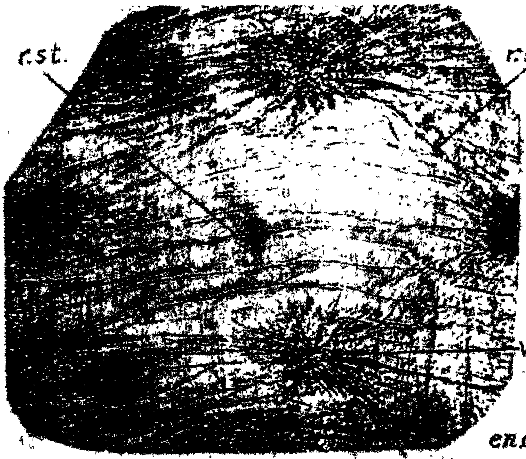
Superficial exudation system ·—Each vesicular group is surmounted in the centre by a sensory hair (Text-fiig. 2, *sh.*). The latter is short and pointed and its base is sunk within a cuticular cup. On microscopical examination it is found that the narrow area immediately surrounding the basal region of the surmounting hair, is like a moat charged with small globules glistening white. Outside the circular moat there occurs a number of very fine dark chitinous ridges radially arranged and these make the area of the integument containing the secretory vesicles rough to the touch. The ridges are confined to the vesiculated area. Interposed between these fine ridges there are impressed lines (Text-fig. 2, *r.st.*) which radiate and then broaden out as they leave the vesiculated area in the form of wavy strands of cuticular tissue passing in different directions so as to link up knots of vesicles that are distributed over the bodywall. Plate I, fig. 1., which is a photomicrograph of a permanent preparation of a portion of the integument, shows these strands (*r.st*). In focussing the lines, the sensory hairs and the apical portion of the vesicles have gone out of the picture and the latter appear in the photomicrograph as large granular dark spots. The connecting strands run along the narrow cuticular infoldings of the bodywall and the tracts so formed are peculiar in not being lined inside by the hypodermal layer of cells which however, are abundantly and uniformly distributed over the rest of the bodywall. Deposits of a brownish substance could be seen on the vesiculated surface. The substance coming out of the vesicles seems to harden on exposure to air, for it is found in fixed specimens firmly adherent to the external cuticle. This exudate is elaborated by the small hypodermal gland cells lining the internal surface of the vesicles (Pl. I, fig. 2, *hy.c.*) and the secretions issue out in fine droplets evidently through pore canals the existence of which could only be proved by studies under Electron microscope (Richards and Anderson 1942). They are poured out as the sensory hair of a vesicular group becomes stimulated by contact with soldiers and workers. Isolated workers could be seen actually licking the vesicles. It is worth noting that vesicular structures like these or their connecting strands do not occur on the external surface of the bodywall in any other phases or castes of the termite species.



TEXT-FIG. 2.

Diagram showing the groups of secretory vesicles with a sensory hair at the centre, in the lateral bodywall of a physogastric queen. *sh.*, sensory hair. *r.st.*, radiating strand.

It may be stated that the ordinary integumental folds or simple plications of the bodywall would occur while the (Pl. I, fig. 3) new cuticle is being laid by the activity of the proliferating hypodermal cells. The simple plications when stretched and smoothed over by the internal pressure of the fluid filling the haemocoele would add to the length and so increase the surface of the bodywall; these at the formative stage are, however, devoid of the secretory vesicles.



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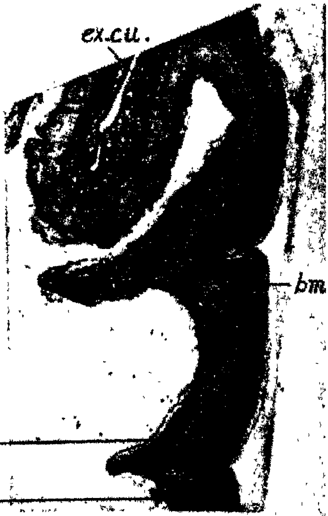

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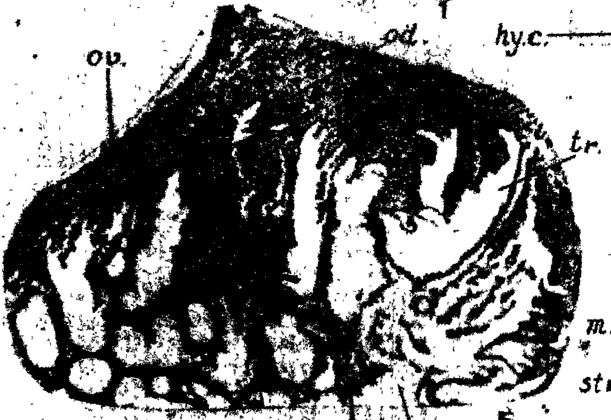

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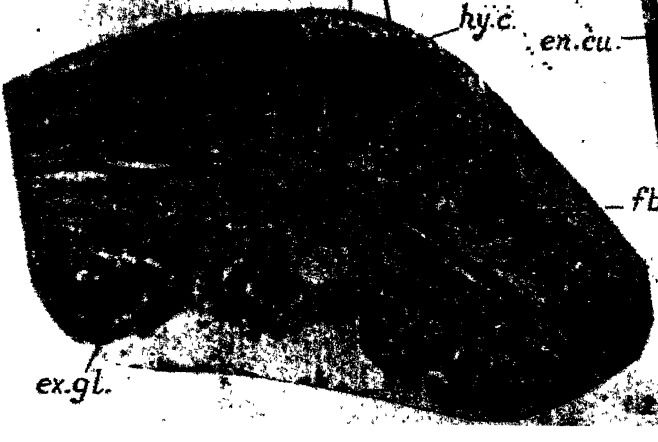
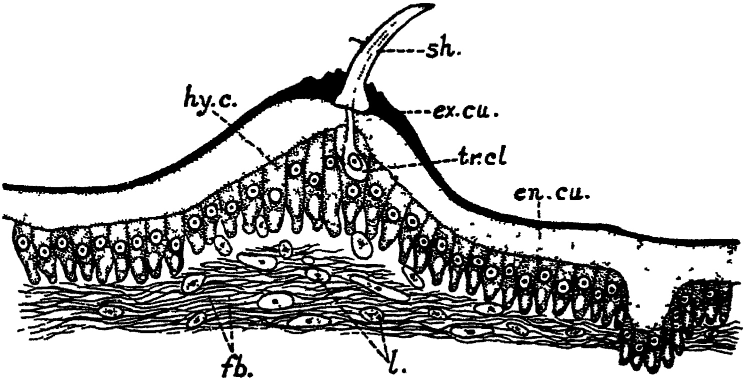


The bodywall in the physogastric queen is composed of the cuticle and the hypodermal layer of cells (Text-fig. 3).

A comparison of the integument of the queen with that of the other phases may now be made. For convenience of comparison the figures drawn on the same scale are given (Text-fig. 4). In both the fully formed worker and soldier castes, the cuticle is exceedingly thin and is not distinguishable into an endo and exo-cuticular layers. It is homogenous and shows no stratification. The hypodermal layer extends as a thin sheet of protoplasmic matrix, nuclei or cellular boundaries having disappeared. Solid cuticular hairs are common in each case. In the larval form the cuticle is thin but the hypodermal cells are distinct. In the dealated male the cuticle is intermediate in thickness between the queen and the nymphs with wing pads.

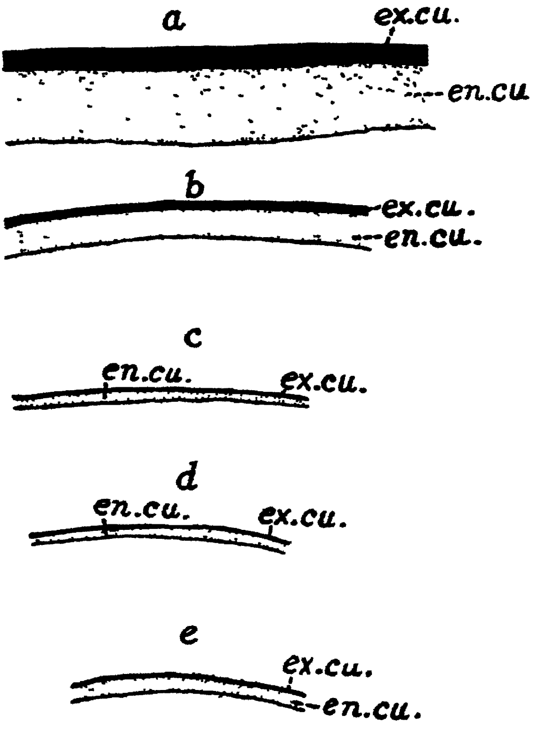


TEXT-FIG. 3.

Diagram of the transverse section through a secretory vesicle. *fb.*, fibrous band of muscle. *l.* leucocytes *hy c.*, secretory cells. *tr cl.*, trichogen cell. Other letterings as in previous figures. Note on the right the ingrowth of the chitinous intima.

It is worth noting that no hypodermal cells occur along the strands of tissue connecting the different groups of secretory vesicles. In a section of the bodywall passing through a connecting strand, a band of refractory tissue is found situated below the endocuticle and running parallel to it (Pl. 1, fig. 4, str.). The refractory band that occupies the position of the hypodermal cells is composed of a shining protoplasmic matrix in which are embedded peculiar spindle-shaped bodies which under lower power of a microscope appear as dark spots scattered within the shining granular protoplasmic mass. On higher manification the cellular nature of these bodies is disclosed, the middle portion of each body being swollen with extremities drawn out in the form of stiff fibres turned in a vertical direction of the figure. The nucleus is lodged in the swollen part. The cell seems to have nothing to do with conduction of secretion although it appears hollowed out in the interior more or less like the porocytes. We are inclined to the view that the nerve stimulus is conducted through this band. The exact significance of these cells within the band however, is not clear from its structure. The refractory band is bathed in the haemocoelic liquid which is non-granular in character in this part of the body. In the figure, clumps of muscles (*m*) could be seen a little below the refractory band.

Minute structure of the secretory vehicles·—The secretory vesicles are evaginations of the body wall. The composition of a secretory vesicle is shown in (Pl. 1, fig 2) The outer cuticular portion like the remaining portion of the bodywall is distinguishable into endo and exo-cuticle. The hypodermal cells lining the lumen of each secretory vesicle resemble epithelial cells and do not show any striking difference from the hypodermal cells composing the general bodywall except in the shape and size. These cells in general are greatly elongated and in a few of these little vacuoles or space could be seen at the inner end (Text-fig. 3, *hy.c.*). The nucleus is prominent. The basement membrane (Pl. 1, fig. 3, *bm*) which is noticeable in other portion of the bodywall as underlining the hypodermal cells, is wanting. Often it is seen that a very fine capillary tube glistening white when viewed under the transmitted light of the miscroscope, passes between two adjacent hypodermal cells and end on the top of the endo-cuticular layer. From the character of the capillary tubes we believe them to be tracheoles ramifying over the integument. At any rate they are different from the pore canals.



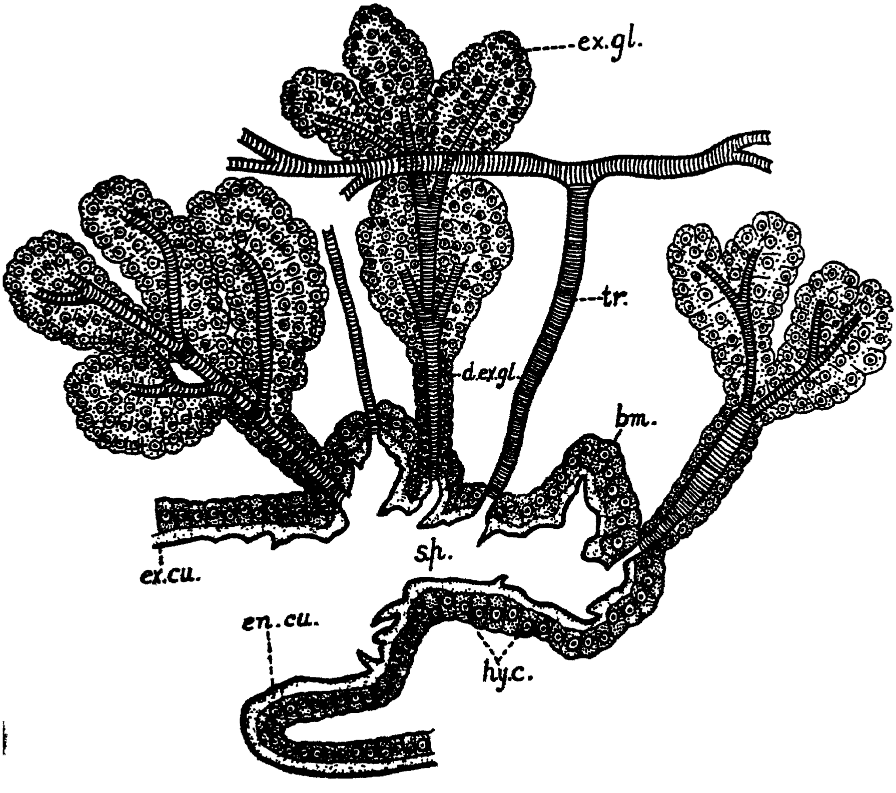
TEXT-FIG. 4.

Camera lucida drawings showing the relative thickness of the cuticle in (*a*) queen. (*b*) king. (*c*) nymph with wing-pad, (*d*) adult worker and (*e*) larva. *ex.cu.*, exocuticle. *en.cu.*, endocuticle.

Though we could not detect any intra-or inter-cellular duct connected either with the hypodermal cells lining the vesicle or with the vesicle itself, we regard these hypodermal cells as glandular in function, the secretion of which seeps out to the exterior. It is difficult in such a case to say that the fluid filling the body cavity and flowing into the vesicular cavities of the integument, does not also ooze out An influx of the haemocoelic fluid or blood into the lumen of the vesicles would take place with contraction of the longitudinal muscles of the abdomen causing turgesence or bulging of the vesicular wall. Along with the body fluid, leucocytes would be carried into the lumen of the vesicles; in sections through a vesicle these are often seen abutting against the base of the gland cells. Below the glandular hypodermal layer, bands of muscles pass across the lumen of the vesicle and thereby imperfectly separate it from the general body cavity. The muscles give off fibres which are attached to the wall of the vesicle or to the integument. In sections through a vesicle, some of the muscle fibres passing across the lumen of the vesicle, do not disclose striations, or the characteristic nuclei, of the muscles. They seem fibrous in character (Text-fig. 3 *fb*). Often a granular protoplasmic matrix surrounds them. Wedged in between these fibrous bands, or scattered within the enveloping protoplasmic matrix, there occurs a number of cells of different shape and size (Pl. I-fig 2, *fb*; text-fig. 3, *l*). These cells in our opinion represent degenerating muscle cells, sarcolytes as well as the leucocytes. The peculiar disposition of the fibrous band is explainable by the fact that with the increase in the surface area of the bodywall, the old muscular insertions on the cuticle degenerate, and fresh muscular insertions arise as the new cuticle is being laid down; leucocytes appear there with influx of the haemocoelic fluid so as to remove the debris of disintegrating tissues.

DEEP EXUDATION SYSTEM

Exudate glands:—The deep exudation system is composed of (1) the exudate glands which correspond to the special exudation tissue of Holmgren or to the columnar tissue of Bugnion, (2) tracheal-like ducts and (3) spiracular apertures. In dissected specimens examined in naked eye the exudate glands look like flakes of a fatty substance whitish in colour and closely applied to the bunches of trache like ducts opening on the spiracles (Text-fig. 1, *d-ex-gl*). Each bunch of ducts is arranged inside like a whorl around the spiracle. The nerve supply of these is shown in the same figure. While a certain portion of the exudate glands is in contact with the internal surface of the body-wall, the major parts hang freely in the body cavity bathed in the haemocoelic fluid. Examined under the low power of a dissecting binocular microscope, the glands are seen to be made up of a number of cellular lobes, which with regard to their distribution are segmentally arranged and converge on to the corresponding spiracles of the abdominal segments (Text-figs. 1; 5). In sections the glandular lobes which take up deep stain, are found fairly distributed throughout the haemocoelic cavity of the abdomen; anteriorly they however, occur in greater abundance in the peripheral regions of the body (Pl. I, fig. 2, *ex. gl.*) They also extend deep within so as to reach the intestine and sometimes pass between the interlacing mass of ovarioles. They however, are not deposited over the wall of the alimentary canal or the ovarioles. As seen in sections, the constituent gland cells bear in mode of distribution a superficial resemblance to the fat cells, yet in structure and development they are altogether different from them. They are distinguishable into (*i*) an outer or spiracular lobe (*ii*) a middle lobe (*iii*) an inner lobe. The outer lobe of the glandular mass presents a different picture from the centrally placed one. The outer lobe of the gland in a segment, as it approaches the corresponding spiracle (Pl. II, fig. 6, *ex. gl.*), appears in naked eye, like the fatty deposits on the walls of the tubular ducts. In cross sections through the spiracular ends (Pl. II, fig. 7, *d. ex.gl.*) the cells are found arranged single layer thick around the ducts. The duct is lined inside by a chitinous intima which in this photomicrograph looks like a dark ring. The thickness of the intima lining the duct varies according to the region of the glandular lobe through which the section passes. The chitinous intima gains in thickness as the duct approaches the spiracle, but gradually thins down as the duct branches out to form the ducteoles running through the compact mass of cellular lobes representing the inner end of the gland. As a result of this arrangement, the outer end of the duct which is in communication with the spiracle, looks like a trachea, the superposed cells comprising the gland resembling the ecto-tracheal layer and the chitinous lining the endo-trachea. (Text-fig. 5). In Pl. II, fig. 7, it may be noted that the portions of ducts which are deeply placed inside, are obliquely cut here and these



TEXT-FIG. 5.

Diagram of a longitudinal section through the abdominal spiracle in the physogastric queen showing the exudate glands, the course of their ducts and the trachea. *tr.*, trachea. *ex.gl.*, exudate glands. *bm.*, basement membrane. *sp.*, spiracular pit. Other letterings as in previous figures.

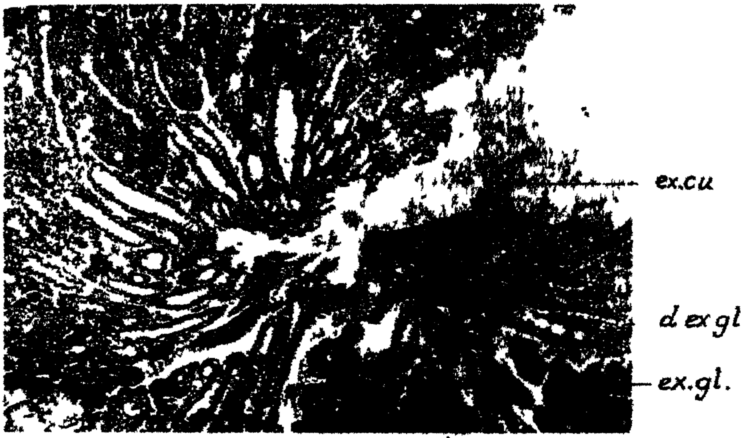
have a comparatively thick chitinous intima, and their cellular coating, too, is very thick. Moreover, the cellular layers surrounding these ducts in few instances, become confluent with those of the neighbouring ducts In consequence of fusion the cellular coating often becomes multi-layered. This is usually seen in the middle portion of the glandular lobe (Text-fig. 5).

The inner portion of the glandular lobes is likewise made of compact mass of cells arranged several layers thick. There are, however, narrow channels or fine fissures between these dense masses of cells (Pl. II, fig. 8). These fissures are interstitial spaces and should be distinguished from the lumen of the ducts. They arise in course of development when the cells which are at first arranged in a single layer thick, become involuted with the increase in cellnumber, so as to form the multi-layered lobes of the gland. These spaces therefore do not function either for storage or for the passage of secretory products of the glands.

The inner lobe of each exudate gland is remarkable for the irregular and dense outgrowths it gives out, which in sections appear as continuous or isolated clusters of cells according to the plane in which they are cut (Pl. II, fig. 8). They occur in plenty at the posterior end of the abdomen in the aged queen. The cells are large in size and look like tall columnar cells placed either side by side or tangentially several layers thick The shape of the constituent cells of the gland varies according as they are placed at the centre or at the periphery of a cluster. The outline of each cell in a lobe is always distinct (Pl. II, fig. 9); the nucleus is spherical with a large nucleolus There is no vacuole nor intracellular duct Cytoplasm contains granules which take up nuclear stains and evidently these represent secretory or rather excretory products. Finer branches of ducts or ducteoles resembling tracheoles are often found traversing the cytoplasm in the central zone.

Comparison with fat cells :—The cellular lobes which we designate for the obvious reason, the exudate glands, differ from the fat cells in not containing any fat droplets (Pl. II, figs. 8,9). They do not form a cell syncytium, the outlines of the constituent cells remaining distinct. Their nuclear structure is also different from those of the fat cells of other insects. In this connection it is worth pointing out that we have not found in the physogastric queen, a separate existence of the fat cells which are common in other phases of termites, and which occur in general in orthopteran or the primitive insects. It might be interpreted that the fat cells were the precursors of the exudate gland cells, and the former as such, were not found in the physogastric queen being transformed in the previous stage into the latter. Had these exudate glands been derived from the fat cells, we would naturally expect that they would be seen at least at the transitional stage of formation in the winged sexual female forms or in still earlier stages.

Let us, therefore, first examine the condition of the fat cells in the winged sexually mature females. The haemocoelic cavity is uniformly filled here with abundance of large globular fat droplets shining white. These fat droplets are reproduced in Pl. III, fig. 11, *f.*, and these appear as white masses surrounded by protoplasmic debris. But the characterstic nucleated fat cells or outlines of any exudate gland cells, either preformed or their anlage, could not be detected at that stage. Evidently the large spherical fat droplets noted in the alate forms, collected thereafter the disintegration of the fat cells that occured in the typical nucleated forms in the preceding stage of the winged female. In fact in the



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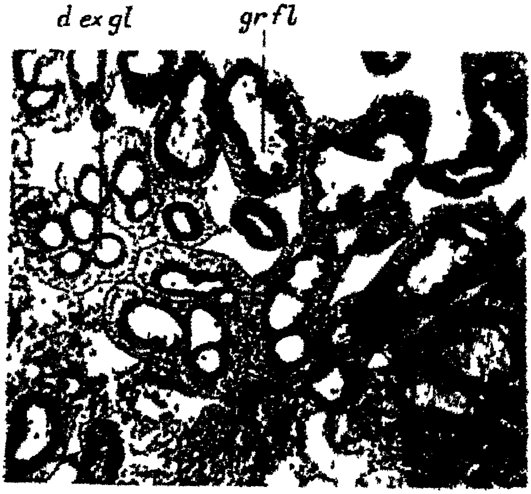

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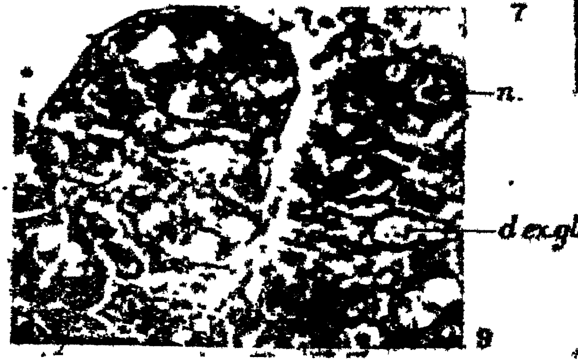

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PLATE II.

nymphs with wing-pads, the fat cells (Pl. III, fig. 12, *f*) occur in sheets, and the structure of their nucleus or the vacuolated cytoplasm enclosing the fat globules, is like those in the primitive insects. The condition of fat cells in the larval forms is of more interest as the latter may be taken for a practical purpose, as the focal type from which the various castes radiate. The fat cells in a larval form is shown in Pl. III, 14, *f* The nuclei are spherical and distinct but the fatty deposits in the cytoplasm are not so prominent as in the nymphs with wing-pads. In Pl. III. fig. 13. *f*., the fat cells of a mature worker caste are shown. Those of the soldier too differ little in shape and size from the worker. In the dealated male accompanying the physogastric queen, the fat cells (Pl. III, fig. 10, *f*) are somewhat different from those of other stages, suggesting that they are now in a semi decomposed state; the nuclei here are distinct and the fat deposits occur in the form of droplets enclosed within the vacuoles. It is interesting to note that in the king, the fat cells have not undergone complete dissolution like that observable in the physogastric queen. In the latter the fat cells have completely lost their identity, so that neither the large spherical droplets of fat, nor fragmentations of the disintegrating fat cells, are found.

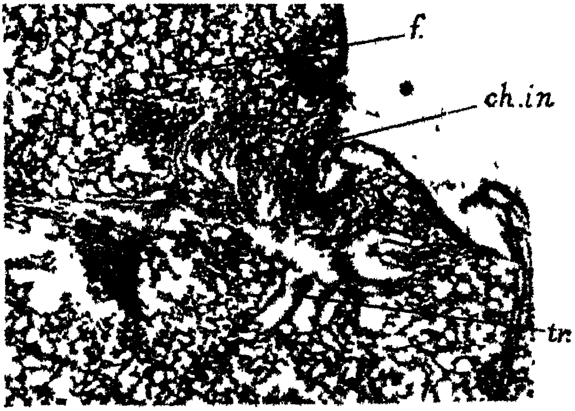
Evidently the process of dissolution of fat cells started in the winged stage, is completed in the queen phase, the fatty deposits together with the decomposing tissues of the alate passing into solution to form a turbid and viscous fluid which tensely fills the haemocoele of the physogastric queen. The same type of fluid does not occur within the body of the previous phases. The extent of liquefaction depends on the age of the queen. In a physogastric queen of comparatively younger age if a section be taken through the abdomen, the haemocoele is found filled with the fluid or blood saturated with fine granules, while in older specimens the body cavity is filled with a non-granular viscous liquid, which is seen in the prepared sections in a coagulated condition.

It should be mentioned in this connection that the exudate glands under discussion are quite distinct from the oenocytes and from the pericardial cells that occur in plenty beneath the mid-dorsal line which is marked with a dark-brown stripe in the aged queen.

Origin of exudate glands:—The mode of origin of exudate glands and their ducts can be traced back to the winged sexual phase or alate forms, although no definitive exudate glands or the ducts could be perceived there, or, at any stage prior to it. In sections through the abdomen of sexually mature alate female, ingrowths of chitinous intima from the cuticular layer are seen to pass inside the body cavity in the form of narrow sticks carrying before them the underlying hypodermal cells which are at the proliferating stage, (Pl. III, fig. 11.)

The sticks do not lend themselves to the formation of apodemes, but are pushed inward towards the growing ovarioles to be converted at a later stage, into a band firmly adherent to the ingrowing ectodermal cells.

In absence of any material in our collection representing the sexual phase at the initial stage of founding new colonies although we could not trace the intermediate stage of development of the exudate glands and their ducts, the indications however, are sufficient to suggest that the invaginated ectodermal cells become modified to form the exudate glands in the queen.



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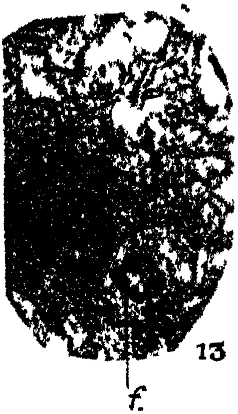

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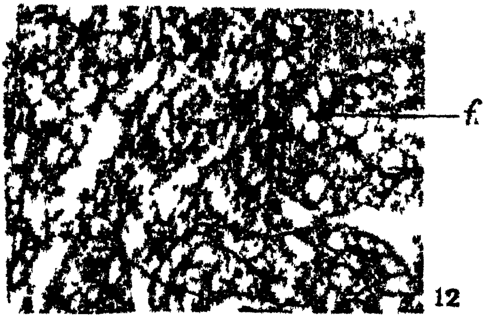

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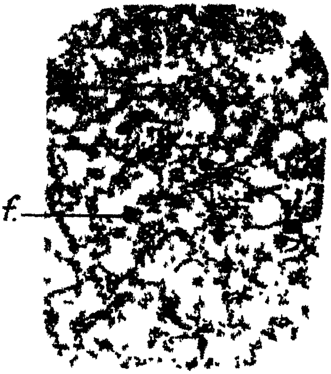

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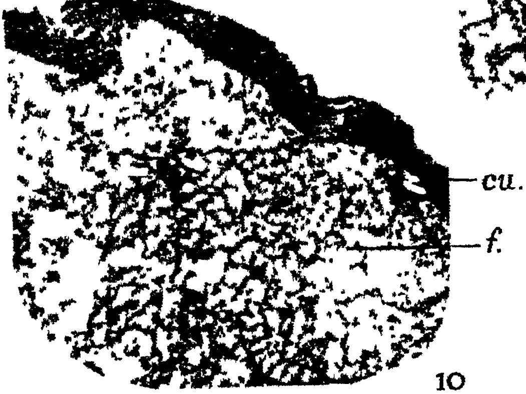

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In certain series of sections through the abdomen of the queen of relatively smaller size and so assumed to be younger in age, the inpushed band resembles a chitinous intima. The cells abutting against this band, are tall and resemble columnar epithelial cells. The latter are penetrated by tracheal-like capillaries. In the central portion of the abdomen, the band is detached and seems to have disintegrated there and, so, it looks as if it was formed by the coagulation of a thick homogeneous liquid.

The granular fluid filling the haemocoele, at first however, is distinct from this, but later comes closer to the outer limit of the disintegrating band. In a few instances a number of leucocytes could be seen migrating within the granular fluid which flows round the decomposed band. The leucocytes approach nearer to the cellular layer of the glands as the adjacent band of intima undergoes degeneration and liquefaction. In rare instances where the band is on the vanishing point, a few leucocytes are found applied against the outer limiting surface of the cellular lobes which are destined to form the exudate glands. In no case however, the leucocytes are found penetrating within the cellular lobes.

The varying morphological pictures of the exudate glands as given by different series of microscopical sections referred to, though appear to be anomalous, really represent the different stages of development of the exudate organs which originate from the ectodermal layer at the winged stage, the process of separation and differentiation from the integument being continued on in the queen stage.

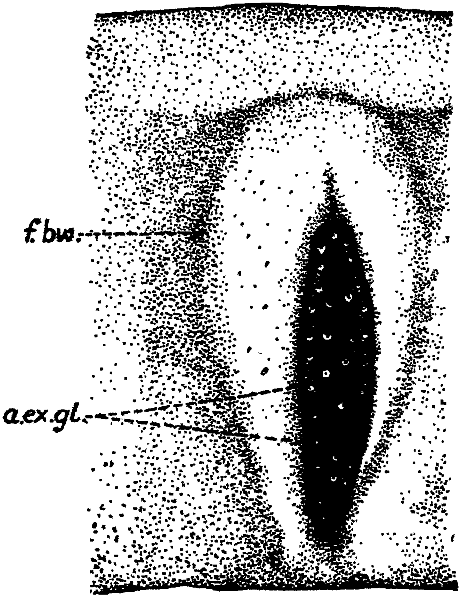
Duct of the exudate glands and the trachea :—The trachea-like ducts of the exudate glands, to which reference has already been made, communicate with the exterior by the small circular apertures situated within the spiracles (Text-fig. 6). The relation of these ducts to the spiracle and the exudate glands, is shown in the photomicrograph of a section of the abdomen passing through spiracle of a physogastric queen (Pl. II, fig. 6).

It is interesting to note that the bundle of ducts of the exudate glands, near their spiracular end, has an inner core of tracheae (Text fig. 5, *tr.*). The lattter open like the ducts by the small circular apertures placed within the spiracle.

The tracheal tubes from the spiracle run for a short course parallel to the ducts and give off branches which supply the alimentary canal, muscles, nerves, the oviducts and other organs. These tubes unlike the ducts of the exudate glands have no thick coating of cellular lobes but yet they could only be distinguished in the freshly dissected specimens. The composite bunch of tubes connected with a spiracle, looks like the spiracular branches of a tracheal system with this difference that instead of a single tracheal tube opening on the spiracle, we have here two sets of tubes namely, the tracheal-like ducts of the exudate glands, and the tracheae proper. One is concerned in conducting the exudate and the other in respiratory gases. The difference between these two sets of tubes is borne out if sections passing through a posterior abdominal spiracle, be closely examined. Dark-brown granules similar to those smearing the external bodywall and issuing through the spiracular pits, are found scattered within the lumen of the ducts near their spiracular end. These are not found within the tracheae proper which appear empty. If serial sections of the abdomen be examined, it is found that the lumen of a few of the deeply placed tracheal-like tubes (Pl. II, fig. 7) which had been cut transversely, contains a clump of very fine granules (*gr. fl*) which curiously look more like a coagulated liquid than the larger brown granules contained within the other ducts.

The ducts and the accompanying tracheae resemble one another so closely in structure, that it is difficult in serial sections of the abdomen to make out any morphological distinction between the two.

In both the sets of tubes, the ectotrachea and endotrachea can be differentiated as in an ordinary trachea of an insect. But there are points of difference between them which are only noticeable when a tracheal tube supplying the oviduct or the wall of the intestine in a mature queen, is separately cut and compared with an isolated duct which is filled with the secretory products. The duct is lined inside by a chitinous intima which is thicker than that of a trachea proper. In longitudinal sections of the ducts, flat chitinous bands are found laid flat like the rungs of a ladder, and the taenidia are not spirally coiled as in the ordinary tracheae of insects; they are more widely spaced out than in the tracheae proper.



TEXT-FIG. 6.

Diagram of an abdominal spiracle of the queen showing circular apertures within the pit. *a.ex.gl.*, apertures of the exudate glands. *f.bw.*, fold of the bodywall.

Moreover, the outer cellular coating of a trachea, say, for example, in the one connecting the spiracle with the oviduct, is exceedingly thin and membranous, the cellular outlines having disappeared with nuclei becoming there indistinct By contrast, the cellular envelope of the duct comparable to the ectotrachea of the above, is fairly thick and not membranous, and the cells are distinct and clear. This coating however, is not uniform in thickness as referred to before. Now while the duct in the spiracular region comes flush with the aperture by which it opens to the exterior, the outer thin cellular coating of the duct merges with the adjoining hypodermal cells lining the internal surface of the bodywall, so that no distinction could be made between the cellular coating of the duct and the lining hypodermal cells of the adjoining integument (Text-fig. 5).

Towards the inner end of the duct, the cellular envelope as noted before, gradually gains in thickness. One of the reasons for this may be that as the duct passes through the cellular lobes of the exudate glands, the single layered cellular coating of the duct corresponding to the ectotracheal layer, merges with the cells comprising the exudate glands. Therefore as the duct with its branches courses through the cellular lobes of the exudate glands, all distinction between the cells, strictly belonging to the coating of the duct and those of the exudate gland, fades away. In fact the two are continuous with each other. This anatomical continuity starts from the hypodermal layer of the bodywall and can be traced along the entire length of a duct as far as the swelled lobes of the inner portion of the exudate gland (Text-fig. 5). No doubt the cells in their passage from the hypodermal layer of the integument to the lobes of the deep exudate gland, show all possible transitional stages in form and shape, but no fundamental structural difference between them could be detected (Pl. II, fig. 6). The continuity in disposition and similarity in finer structure of the cells concerned, are conceivable if we accept the origin of the exudate glands from the hypodermal cells of the integument.

It is interesting to report in this connection that we failed to find within the abdomen of the queen the large longitudinal tracheal trunks which commonly exist in the winged insects (Pl. III, fig. 11.) These evidently degenerated and disappeared here together with their branches so as to make room for the growing mass of exudate glands, ovarioles and the enlarged alimentary canal of the physogastric queen. On making comparison with the alate forms, it seems as if the tracheae gradually dissolved away since they came in close contact with the growing ovarioles. We came to this view because in the winged sexual forms, an abundance of tracheal branches is noticed near the ovarioles (Pl. III, fig. 11, *tr*). These, however, are conspicuous by their absence in the queen where the ovarioles increased in size and number. The disappearance of the major tracheal trunks and the concomittant appearance of the exudate glands together with their tracheal-like ducts in the queen, are suggestive of the replacement of the one by the secondary formation of the other as the winged forms pass into the wingless queen phase.

Spiracles :—The spiracles in the mature queen (Text-figs. 1, 5, 6) are peculiar that they resemble cup-like depressions of the bodywall, having its floor and side walls perforated by a number of circular apertures. The mouth or external aperture of the spiracles is reduced to a narrow elongated slit in being overhung by a folding of the adjoining integument (Text-fig. 5. *sp.*). Owing to the peculiar nature of the spiracles, we have referred these in this paper, as spiracular pits, while the mouth-slits of these have been called by Bugnion, the spiracles. The perforations within them are the external openings of both the ducts and the tracheae. The apertures are distributed on the side walls as well as on the floor of the spiracular pit. All the apertures within the pits are round and can be easily seen in surface view if the spiracular pits, which are sunk within the folds of the bodywall, be exposed and examined under a dissecting binocular microscope (Text-fig 6, *a ex.gl*). They are wide enough to admit the passage of blunt entomological pins In general the centrally placed apertures lead into tracheal tubes and the peripheral ones into the ducts. No morphological distinction could, however, be made between the apertures connected with the ducts of the exudate glands and those of the tracheae proper.

As to the size of the spiracular pit, it may be noted that in a specimen 70 mm. long, the pit if opened out, measures, 1 4 mm. in length and 2.5 mm. wide. The rim of its mouth-slit is flush with the bodywall and is marked by a weakly chitinised ridge. The mouth-slit of the spiracle with its major axis lies in the transverse direction of the body (Text-fig 1).

The circular apertures within the spiracular pits, it may be observed, do not lead into an atrium. Moreover neither the mouth slit, nor the cup-like spiracular pit, nor the apertures in it, are provided with a closing apparatus of any kind, and no peritreme could be distinguished at any place.

Inspite of the above difference between these pits and the true spiracles, there are close similarities between the two as regards their segmental arrangement and also their connections with the trachea-like tubes, to warrant the use of terms the spiracular pits and spiracles, as synonymous.

Now there are six pairs of spiracles in the abdomen of the queen It is remarkable that the first pair of abdominal spiracles differs in shape and position from the rest which agrees with the description of the spiracular pits given above. The first pair are placed on the lateral border of the corresponding tergite, exposed to the exterior and not sunk within the folds of the bodywall like the spiracular pits Each member belonging to the first pair opens to the exterior by a single circular aperture which can definitely be homologised with the external spiracular aperture of insects with this distinction that it, likewise the posterior abdominal spiracles, acts as the outlet for the discharge of secretory products of the exudate glands, the ducts of which open on it.

It is also noteworthy that while the first abdominal pair closelv resembles in shape, structure and position the corresponding spiracle of the fully formed winged sexual female, the remaining abdominal pairs in the queen called the spiracular pits differ from those of alate forms in being placed far removed from the lateral margin of the corresponding tergites and having an outer slit of elliptic shape and numerous aperatures inside them as remarked before.

In the winged forms all the abdominal spiracles are built like the first pair, the external spiracular apertures being small and circular in outline and exposed to the exterior. Each of these spiracles is surrounded by a peritreme ring and leads into an atrium communicating with the tracheae, and has got nothing to do with the passage of the secretory products, the exudate glands being wholly absent there.

The exuding spiracles of the pit type described here are a special feature of the queen only and are not observable either in the males or nymphs with wing-pads or in immature larval forms. In the mature worker or soldier castes, also, the exudate glands and the special type of spiracles noted in the queen, do not exist.

Nature of the exudate:—The exudate passing out of the spiracles of the abdomen of the queen is a greasy fluid, brown in colour containing an abundance of granules which look like small spherical crystals. Workers and soldiers congregate round the abdominal spiracles to lick this exudate. This can be easily observed under a magnifying hand lens, if the queen, immediately it is dug out of the mound, is transferred to a glass jar of wide diameter, and kept there along with a large number of soldiers and workers of the same nest. The exudate is poured out in such a quantity that if it be not imbibed, for a shortwhile, by the attendant soldiers and workers, it overflows the spiracular pits and the entire body of the queen becomes besmeared with it and feels greasy to the touch. The overflow of this exudate over the body is aided by the rhythmic contraction of the abdomen. A peculiarity worth noticing is that towards the closing days of the queen in our artificial glass-nest when she is left alone being deserted by the soldiers and workers, the exudate covers her body like a thick scum, and the queen thereafter expires. It is difficult to say whether the thick slimy scum is the result of accumulation of the excreted substance not being removed by the workers and soldiers as these are discharged to the outside, or, is due to the excessive secretory activity for counter-effecting the drying effects of atmospheric air in the artificial nest, the queen being inured to humid condition in the subterranean nest.

DISCUSSION

The physogastric queen liberates exudates which are of two types: (i) liquid droplets issuing from innumerable glandular vesicles microscopic in size and distributed over the sides of the abdominal wall (ii) greasy fluid flowing out in abundance through a number of tumid circular apertures placed within the spiracular pits which are segmentally arranged on the sides of the abdomen.

These two modes of liberation of exudates were not reported by the previous authors. It is quite possible however, that the liquid contents of the bodycavity seep out through the bodywall so as to constitute the exudate of the superficial type, when the vesicular areas bulge out by the internal pressure of the blood as the abdominal muscles contract. In this respect Holmgren's view that in certain cases the exudate comes out through pores of the bodywall is not greatly at variance with our observations. In exploring the exudate issuing from the vesiculated areas, the sensory hairs of the vesicular groups are touched by the workers and soldiers stimulating thereby secretions from the vesicular bodywall which is richly innervated by nerve twigs. The interconnections between the vesicular groups by the refractory strand of tissue, perhaps help in the transmission of the stimulus to a wider zone if any one of the vesicular groups is stimulated through its sensory hair. It is superflous to point out that the hair in the centre of a vesicular group is not hollow and does not conduct the secretions as indicated by Holmgren. It is sensory in function. It was not reported by Noyes (1930) under the peripheral sense organ.

The cellular lobes representing the glandular elements in the deep exudation system, were known to previous investigators, but their communication with the exterior as noted here, was missed by them. Apparently this led to mis-interpretation of structures and functions of the organs concerned. Holmgren described these glands as the special exudation tissue. He correctly noted the character of epithelial-like cells composing the glands and the absence of fat droplets in the latter. He was wrong however, as already pointed by Bugnion, in thinking that secretion of these glands passed into the surrounding liquid contents of the haemocoele to be discharged to the exterior through hollow hairs or trichomes There are no hollow trichomes, and the contention of Bugnion in this respect is correct The latter author also correctly noted the disposition of the glands in relation to the spiracles, as well as the passage of tracheal-like tubes through the glands which he called "Colonnette" or Columnar tissue. Unfortunately he did not notice the external openings of these tubes on the spiracular regions, and so came to the erroneus conclusion that the exudation tissue was a kind of gland having an internal secretion which did not pass to the exterior.

With regard to the homology of the exudate glands, the divergent views may be summed up as follows : (*i*) origin of these glands by (*a*) direct transformations of fat cells (Holmgren) (*b*) by conversion of fat cells by agency of leucocytes (Feytaud), (*ii*) origin from tracheal gland cells (Bugnion)

Now if the condition of fat cells in the different phases be reviewed, it is found that the fat cells in all excepting the winged sexual and the dealated queen, are more or less alike, forming cell syncytium and having vacuoles. Their nuclei are prominent. In the winged sexual female, however, the abdomen is full of large fat droplets but cellular outlines, or the nuclei characteristic of the fat cells, are not visible here. In the physogastric queen, neither the large fat droplets of the stage immediately preceding it, nor the fat cells characteristtic of the earlier stages, are found In our opinion the fat cells have completely broken down in the physogastric queen and have liquified along with degenerative old tracheal and muscular tissues so as to form the viscous and granular liquid or blood filling the haemocoele. The fat cells with their contents once having liquified or passing into solution, can not be expected to rechange into the constituent cells of the exudate glands when we find the products of decomposition of the fat cells and the definite exudate glands coexisting. Furthermore, reformation of the decomposed fat cells into gland cells is not a possibility, the one being mesodermal and the other ectodermal in origin. In fact the fat cells do not give rise to the epithelial-like cells comprising the exudate glands as had been correctly pointed out by Bugnion. The fatty substances dissolved in the haemocoelic liquid by disintegration of the adipose cells, are absorbed evidently for supplying the requisite nutritive material needed by the multitude of developing eggs in the ovarioles. The gradual degeneration ot adipose and other tissues of the sexual alate phase as the physogastry develops, would account for the infiltration of leucocytes into the degenerating tissues. This might have led Feytaud to wrongly infer the transformation of fat cells into the special exudation tissue by the agency of leucocytes. Our observations thus discredit the view of origin of the special exudation tissue from the fat cells either directly or indirectly through the agency of leucocytes. The latter were concerned in histolysis and removal of cell debris. Again, we differ from Bugnion with regard to the homology of the exudate glands. The cells composing the exudate glands are derived from the hypodermal layer, and as such at the initial stage of formation and differentiation, these are found attached to the inner surface of the chitinous intima when the latter is pushed in by the ectodermal invagination at the spiracular regions. The depressed areas of the bodywall form the spiracular pits. The invaginated ectoderm gives origin to the lining intima of the ducts, and to the cells of the exudate glands. This mode of origin of the exudate glands and their ducts, explains the anatomical continuity observed in the physogastric queen, between the hypodermal cells lining the bodywall, the cellular coating of the ducts and the lobes of the exudate glands.

Since no moulting occurs in the queen, the remarkable post-adult growth of the abdomen leading to physogastry, could be possible by the shedding of the endocuticle and muscular insertions of the old bodywall, into the interior of the body cavity, as new growth material is added, demanding new muscular insertions. The endocuticle together with the subjacent hypodermal cells and muscular attachments thereon becomes detached from the integument and passes into the interior of the body cavity. The detached intima disintegrated there while the hypodermal cells associated with the intima, retain their activity, multiply and migrate inward. It is for this reason that often we find in sections of the abdomen, a disintegrating cuticular intima appearing within the body-cavity in the form of a broad non-cellular band of tissue, non-stainable by the reagents used by us, and a block of epithelial-like cells attached to this band and sinking in towards the centre of the abdomen. These cells migrating inward, proliferate, and thus add to the mass of exudate glands as growth proceeds. The detached intima subjected to the disintegrating influence of blood is decomposed. With the dissolution of the intima the leucocytes wander away, while the ingrowing ectodermal cells, rapidly multiply, wrap themselves round the ducts and their finer branches. This process reinforces the constituent cells of the exudate glands already formed by ectodermal invagination in the spiracular regions, and explains the continued expansion or increase in size of the exudate glands with the growth of the abdomen in the queen.

A question now arises whether the deep exudate glands which are arranged in the interior of the abdomen as cellular lobes bathed in the haemocoelic fluid are to be looked upon as secretory or excretory in function. Since we find the malpighian tubules in the physogastric queen to be wholly different from those of other phases and their histological structure is suggestive of secretory rather than excretory function, we consider that the exudate glands extract nitrogenous waste or decomposed products from the blood. The exudate formed by the activity of these glands and finally discharged to the exterior through trachea-like ducts opening on the spiracles, should be regarded therefore as the excretory product of the body. The heterogenous nature of this exudate holding in suspension crystal-like brown spheres or granules also points to such conclusions. The licking of excretory products is also in keeping with the general habit of termites which feed on proctodeal food or ejected matter.

The structure of the duct composed of ecto-and endo-tracheal layers with spiral thickenings and the mode of development, suggest that the ducts are homologous with the tracheae, and the ducteoles to tracheoles. The component cells of the exudate glands penetrated by ducteoles can on that ground be homologised with the tracheal end-cells. Since both the ducts and the few tracheae persisting in the queen similarly open on the spiracular pits though by distinct apertures, we regard the ducts as the tracheae which have switched on to a newer function made possible by reversal of tropism and development of a large surface of integument for supplementing respiration in a humid atmosphere. The rise of liquid column in the finer tracheal branches shown by Wigglesworth (1939) is significant from the point of view of turning of the tracheal tubes to conduction of an excretory liquid as the osmotic tension of the body fluid rises and waste products accumulate in the body cavity. It is remarkable that the abundant tracheal branches penetrating the ovarioles of the sexually mature winged females and the longitudinal tracheal trunks of the winged forms, have greatly disappeared in the physogastric queen. Could the change in the respiratory system as remarked by the senior author (Mukerji, 1942) be due to alteration of blood induced by the special mode of nutrition of the queen which unlike other phases or castes exclusively depends upon the stomodeal food given to her by the workers and soldiers, or could it be due to the slowing down of the rate of oxidation of the tissues as the sexual forms after dealation, take to a passive life under moist earth ? At any rate the queen shut up as a prisoner within the narrow confines of the moist chamber, by contrast with the sexual alate forms which are fliers and are attracted to light, leads a passive and inactive life which does not call forth high oxidation of tissues.

The cuticle of the wide intersegmental zones, on the dorsal and ventral aspects, is exceedingly thin and membraneous and so well suited for supplementing respiration in a humid atmosphere as the old tracheal system disappears or switches on to some other function. We do not, however, consider the ducts of the exudate glands as remnants of the old tracheal system but are new formations which are not concerned with respiration but conveyance of the exudate from the glands placed within the interior of the abdominal cavity to the exterior

The difference in structure between the spiracles of the winged sexual phase and the mature queen support such a view. In the alate forms all the spiracles are small circular apertures, whereas in the queen, all the spiracles except the first abdominal are large cup-like depressions or pits in the bodywall and occupy a different position in relation to the body. Their floor and side walls are pierced by numerous circular apertures representing external openings of the ducts, while the mouth of the spiracles is an elliptic slit. They are new formations and seem to be intermediate between the simple and a triate type of spiracles mentioned by Snodgrass (1935); we have indicated them in this paper as spiracular pits; the exudate after being discharged, first collects within these pits, and the workers congregate there to lick the greasy fluid.

The gradual passing into solution of the endocuticle, old muscular fibres attached to the bodywall as well as of the tracheal system of the alate forms, increases the volume of the haemocoelic liquid which therefore tensely fills the abdominal bodycavity. The workers and soldiers as they lick the exudates from the particular areas of the body or bite the bodywall in search of the fluid, stimulate the hypodermal cells which proliferate rapidly and lay down new cuticle. The bodywall becomes infolded at the centres of growth as the fresh integument is laid by the activity of the hypodermal cells. By the pressure of the haemocoelic fluid which gains in volume owing to the liquefaction of old tissues within the abdomen, the fold smooth out leading to the increase of the intersegmental membranes and hence of the bodywall.

Assuming that Holmgren was right in thinking that exudation was given out by all the members of a termite colony, there should be a quantitative and a qualitative difference in exudation between the queen and the rest since the secretory vesicles and the exudate glands do not occur in any other phases except the queen. The workers and soldiers are drawn to the queen in her solitary chamber by chemotropic action of the exudates and an association is formed for the mutual benefit. Holmgren's view that more the queen is fed more exudates she gives out, appeals to us. The copious flow of exudates encourages the workers to lavishly feed the queen. The enlarged alimentary canal of the queen as compared to other phases, also point to such a conclusion. The mid-gut of the queen contains abundant 'nest cells' by the rapid multiplication of which the mid-gut increases in size.

The development of the exudate glands and the growth of the abdominal wall and the ovarioles in the queen seem to go *pari-passu*. It is however, difficult to say in what particular way, exudation influences the growth of the ovarioles. Could it be possible the other way, namely, the growing ovarioles after dealation inducing the changes leading to the remarkable post-adult growth of the queen? This seems plausible because the dealated male accompanying the queen and sharing similar conditions of life, does not show such a high rate of growth.

Since the workers feed the queen likewise the other castes, the grooming habit being common, and there occurs occasionally more than one queen in a nest of this particular species, Holmgren's views of selective feeding and inhibition of sex, on that ground, hardly seems tenable. It should, however, be remembered that the diet of the queen is different from that of the rest in as much as the workers and soldiers take fungus and cellulose as food in addition to the stomodeal food. What one can say is that the queen gets adequate nutrition during the egg-laying period in exchange for her exudates, and her attendants in licking the exudates or biting her bodywall to get at the fluid substance, impart the necessary stimulus to growth leading to physogastry.

CONCLUSIONS:

1. The exudates issue through the special areas of the bodywall, *viz*. secretory vesicles and spiracular pits. They are special features of the physogastric queen.
2. The vesicles occur in groups on the sides of the external bodywall. They are glandular and sensory in function.
3. The vesicular groups are connected with one another by refractory strands of tissue so that any one of them act as the focal point of a stimulus.
4. The exudate glands correspond to the special exudation tissue of Holmgren, and are made of cellular lobes ectodermal in origin occuring in abundance within the haemocoele and distinct from other excretory organs.
5. These glands eliminate a greasy fluid or exudate which is an excretory product of the body.
6. This exudate is conducted to the exterior through ducts which are tracheal in origin.
7. The ducts open to the exterior by distinct circular apertures within the spiracular pits.
8. The spiracular pits are homologous to spiracles but are secondary formations. The exudate collects within the pits.
9. Longitudinal tracheal trunks and tracheal connections of ovarioles of the alate phase are wanting, as a result of adaptation to a passive life under the moist ground. The adaptive changes are remarkable since these occur during the life time of the same individual and are hereditarily fixed.

10. Respiration is supplemented by intersegmental membranes.
11. Fat cells have nothing to do with the origin of the exudate glands; they degenerate and pass into solution and thereby supply nutritive material to the developing egg cells.
12. Large tracheal connections and old muscular fibres attached to the body-wall also degenrate and pass into solution of haemocoelic liquid or blood. They make room for growing ovarioles and the enlarged alimentary canal.
13. The passing of the disintegrating tissues into solution along with the special mode of nutrition of the queen alters the composition of blood and influences the development of the exudation system. It also increases the volume of blood which tensly fills the body cavity and this tension reacts on the growth of the bodywall.
14. The workers and soldiers congregate on the bodywall of the queen in search of the exudates. In licking the exudates the attendants stimulate the proliferation of hypodermal cells which add new cuticle.
15. Expansion of the bodywall and development of the exudate glands go together.

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EXPLANATIONS OF PLATES.

PLATE I.

Fig. 1.—Whole mount of a portion of the lateral abdominal bodywall in the physogastric queen showing groups of secretory vesicles (*v*) connected by refractory strands (*r.st.*) after treatment with KOH × 41.

Fig. 2.—Transverse section through a secretory vesicle in the queen showing the secretory cells (*hy.c.*), fibrous bundle (*fb.*), leucocytes (*l.*) and exudate glands (*ex gl.*) × 280.

Fig. 3.—Transverse section through the cuticle in the intersegmental zone in the abdomen of the queen showing the exocuticle (*ex. cu.*), endocuticle (*en. cu.*), hypodermal cells (*hy.c.*). and basement membrane (*bm.*) × 280.

Fig. 4.—Tranverse section through the integument (*en. cu.*), of the queen showing the refractory strand of tissue (*str.*) and muscles (*m.*) × 250.

Fig. 5.—Transverse section through the abdomen of the winged adult female showing the mass of trachea (*tr.*) running through the ovarioles (*ov.*) and oviduct (*od.*) × 180.

PLATE II.

Fig. 6.—Longitudinal section through the spiracular region of the queen showing the openings of the ducts of the exudate glands (*d ex.gl.*) into the spiracular pit (*s.p.*). Other letterings as in previous figures × 47.

Fig. 7.—Transverse section through the abdomen of the queen showing granular liquid within the lumen of the ducts (*gr.fl.*). Other lettering as in previous figures × 150.

Fig. 8.—Transverse section through the abdomen of the queen showing the structure of exudate glands (*ex.gl.*) in the centre of the body × 280.

Fig. 9.—The same as in figure 8, highly magnified to show the component cells of the glands, (*n.*) nucleus, letters as in previous figures × 1120.

PLATE III.

Fig. 10.—Transverse section to show the fat cells (*f.*) and cuticle (*cu.*) in the king × 280.

Fig. 11.—Transverse section through the abdomen of the adult winged female showing trachea (*tr.*) inside, ingrowth of chitinous intima (*ch. in.*) from the invaginated cuticle and fat cells (*f.*) filling the haemocoele × 280.

Fig. 12.—Transverse section to show the fat cells (*f.*) in sexual nymph with wing-pads × 280.

Fig. 13.—Transverse section to show the fat cells (*f.*) in adult worker × 280.

Fig. 14.—Transverse section to show the fat cells (*f.*) in larva × 280.

BIOLOGICAL NOTES ON THE BUTTERFLIES OF DELHI

Part I. *Papilionidae* and *Pieridae*

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INTRODUCTION

Butterflies have been from time immemorial the object of natural history study. Their habits in natural sorroundings have been neglected in some parts of the world especially India. There is a considerable amount of information on Indian butterflies of hills as well as of the plains but so far no serious attempt has been made to study the butterfly fauna of Delhi. In 1903, Longstaff, in his 'Butterfly Hunting in Many Lands' recorded about a score of species from Delhi.

The present paper is based on an extensive field study of Delhi and its environs (over ten miles radius) during 1941-1942. The material comprises sixty two species, representing 34 genera of the families *Papilionidae, Pieridae, Nymphalidae, Danaidae, Satyridae, Lycaenidae* and *Hesperidae.*

I take this opportunity of expressing my deep sense of gratitude to Dr. Hem Singh Pruthi, Imperial Entomologist, for facilities for work and for constant encouragement. My thanks are also due to Messrs. Mohan Singh and M. S. Mani, for the valuable suggestions and help from time to time. Lastly, I am grateful to Mr. G. D. Bhasin, Asst. to the Forest Entomologist, Dehra Dun, for his valuable criticism of the paper.

TECHNIQUE OF COLLECTING BUTTERFLIES

Butterflies, like *Papilio* and *Catopsilia* spp., having swift, galloping and jerky flights are successfully captured by a net 12 to 18 inches in diameter, having a handle about 4-6 feet long. Others, like *Danais* and some *Pierids* having weak, hesitating and short flights can easily be caught with a small hand-net even after they have been disturbed. *Satyrids* and *Lycaenids* which generally remain on low vegetation can best be collected by quickly placing the net over them from a distance. Members of *Papilio, Colotis, Eurema, Ixias, Danais,* and *Ergolis* are easily captured while in copulation. Butterflies, like *Atella phalanta* and *Colotis fausta,* can be collected with hand by the edge of the folded wings while engaged in sipping nectar from their favourite flowers.

During winter, 10 a.m. to 3 p.m., is the best period for butterfly collecting as most of them are rarely seen on wing early in the morning and late in the evening. During summer, morning hours are the best, though some species, like those of *Colotis, Eurema, Danais,* and *Ixias* etc., remain active up till afternoon.

In order to prevent butterflies from rubbing off their scales, the usual method of pinching the underside of thorax with a light pressure between the thumb and the index finger had been found to be the best.

Family PAPILIONIDAE Leach.

Polydorus aristolochiae aristolochiae (Fabricius).

1775. *Papilio aristolochiae* FABRICIUS. *Syst Ent.*, p. 443
1939 *Polydorus aristolochiae aristolochiae.* TALBOT *Fauna Brit. India*, (2nd ed) I:86, fig. 15

Common name.—This butterfly is commonly known as the 'red-bodied swallow-tail'.

Distribution.—It is very widely distributed and has been recorded from Ceylon, India, Burma, Thailand (Siam), China, Malacca, Java and the Philippines. In India it has so far been recorded from several localities in the north-west, west and the south; it is also found in Assam and Sikkim. It is usually seen flying during December, January, April and May in the Kumaon Terais. At low elevations in the Palni Hills it flies during May and June and from August to October. At Delhi it has been collected both during autumn and spring *i.e.* from August to November and from March to May; it is more abundant in the latter season.

Larval food-plants.—Caterpillars feed mostly on leaves of the wild twiner *Aristolochia indica* and also on other plants like *Lagenaria vulgaris* and *Luffa aegyptiaca.*

Early stages and habits.—Eggs are usually deposited on the under surface of leaves. The full-grown larva, is uniformally yellowish-red and feeds on leaves and in the absence of leaves on green fruits also. Pupation takes place on the food-plant, head directed upwards by a cremaster and a girdle encircling the thorax and wing cases. The pupa is generally brown in colour.

The total life-cycle, as a rule, occupies about a month and a half. Hibernation generally takes place in pupal stage, which varies from 10—303 days. The butterfly has one to five generations in a year.

Undisturbed and unalarmed, the butterfly flies slow, fluttering upon flowers and sailing over trees The flight is then direct, long and for a considerable time remains almost parallel to the ground. When indulging in courtship, the butterfly rises about 20 feet high and sometimes even more. Two to three males follow a single female which repulses them by quick darts. After long flights the butterfly rests with its wings spread out and on rainy days under the protection of leaves. Adults are fond of sipping nectar from flowers of *Lantana indica, Jatropha panduraefolia, Tagetes erecta, Ageratum conyzoides* and *Punica granatum.* Freshly emerged specimens emit a very unpleasant odour from their bodies, probably for the purpose of repelling enemies.

Papilio polytes romulus Cramer

1775. *Papilio romulus* CRAMER, *Pap. Exot.*, I: 67. pl, 43, fig. A.
1939. *Papilio polytes romulus*, TALBOT, *Fauna Brit. India*, (2nd ed.) I : 178, fig. 46 ♂.

Common name.—This butterfly is commonly known as the 'Common mermon'.

Distribution.—It is known from Burma, Ceylon, Andamans, Nicobars, Thailand (Siam) and Malayan sub-region to Sumatra. In India it has been recorded to occur throughout the plains. At Delhi the butterfly has been collected from February to May and August to November, but is common during October.

Larval food-plants.—Caterpillars generally feed on leaves of *Zanthoxylum robusta, Glycosmis pentaphylla, Citrus medica, Citrus decumana.* At Pusa, it has been reared on *Murraya koenigi.*

Early stages and habits.—Eggs are usually laid during day, singly on leaves or on tender leaf stalks. The larva feeds on leaves. Pupation takes place as in the foregoing species.

The butterfly is a fairly strong flier. In its general habits it resembles the preceding species. Males are generally found darting across paths and shady places. Female butterflies are found less active and few in number. Adults are generally observed sipping nectar from flowers of *Jatropha panduraefolia, Boerhaavia repanda, Ageratum conyzoides* and *Carissa carandus.*

Papilio demoleus demoleus (Linnaeus)

1758. *Papilio demoleus* Linnaeus, *Systema Naturae* (**10**): 464.
1939. *Papilio demoleus demoleus* Talbot, *Fauna Brit. India.* (2nd ed.) **1**: 189. fig. 50.

Common Name.—This butterfly is commonly known as the 'lime or lemon butterfly'. In Godavari and Kistna districts of South India the caterpillars of this species are named as *'nima aku purungu'.*

Distribution.—This butterfly has been recorded from Ceylon, Upper Burma (upto a moderate elevation) , Persia, Arabia, China and Formosa. In India it has been recorded almost throughout the year. At Peshawar the butterfly is found occasionally during March, June and July. At Bannu (N.W.F.P.) it is common from July to November. At Delhi the butterfly has been found throughout the year except January. It is rare during winter but abundant both during spring and autumn.

Larval food-plants.—The larvae generally feed on leaves of *Trickcdesma indicum, Feronia elephantium, Glycosmis pentaphylla, Zizyphus jujuba, Ruta graveolens, Citrus decumana, Chloroxylon sweitenia, Psoralea corylifolia, Murraya koenigi, Citrus* spp., (malta, lime, orange) and *Aegle marmelos.*

Early stages and habits.—Pale-yellow eggs are laid singly anywhere on leaves and shoots Four to twelve eggs may be found on one shoot, and each leaf according to the size may have as many as four eggs The young larva on hatching starts feeding on tender leaves biting them from edges inwards. It continues feeding on leaves throughout its larval stage The full-grown larva is generally yellow-green. On being disturbed it throws out a pair of red osmateria in the shape of a Y from behind the head. The larvae are generally destructive to young citrus plantation: Pupation takes place on twig, but occasionally on leaf. In cold places it hibernates as pupa. According to Ghosh (1914)[1] pupae are of three different colours, (1) green, (2) yellowish-brown and, (3) dark grey with black markings.

The butterfly completes one life-cycle in 22 to 104 days. It has four broods in a year, two before, one during and one after the rains

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1. Ghosh, C. C., Mem. Dept. Agric. India, Ent., Ser., **5** (i): 1—72

The adult is a fast and strong flier, rarely rising 10 to 15 feet above the ground; somtimes, when flying sportively, it rises even higher. A female, chased by a male, generally takes a zig-zag route or hovers over citrus trees or other plants which come on its way. When feeding, the butterfly settles for a few seconds on the flower and keeps its wings in incessant fluttering motion. At daytime it is rarely found taking rest Adults are fond of sipping nectar from flowers of *Hibiscus rosasinensis, Hibiscus esculentus, Euphorbia pulcherima, Conyza ambigua, Lagerstroemia indica, Bougainvellea* spp., *Jatropha panduraefolia, Carissa spinarum, Lantana camara, Lantana indica, Zinnia harmony* and *Punica granatum.*

Family PIERIDAE Duponchel

Leptosia nina nina, (Fabricius)

1781 *Papilio xiphia* FABRICIUS, *Spec Ins*, II: 43.
1793 *Papalio nina* FABRICIUS, Ent. Syst. (3) I: 194 (nom. nor. proxiphia, praecc.)
1939. *Leptosia nina nina* TALBOT, *Fauna Brit. India*, (2nd ed.) I. 305 fig. 108.

Common name.—This butterfly is commonly known as the 'psyche' or the 'wandering snow-flake' on account of its appearing sometimes in countless numbers.

Distribution.—It has been recorded from Ceylon, Burma, China, Malya and the Andamans. In India it has so far been recorded from the lower ranges of the Himalayas from Mussoorie to Sikkim, central, western, southern and some parts of eastern India. It is absent in the desert tracts. At Delhi it is rare and is available during November only.

Larval food-plants.—Caterpillars feed on leaves of *Capparis heyneana* and *Crataeva religiosa.*

Early stages and habits.—Eggs are generally laid on the underside of cauline leaves. The greyish-green larva feeds on young leaves, generally remaining on the under surface but may be found on the upper-side also. The pupa is transparent green, often suffused with pink. Pupation takes place on the under-sides of leaves. Pupal period lasts for a week.

The butterfly is the weakest of the Pierid flier, having a slow and irregular flight. It never rises above a foot or so from the ground. It is conspicuous when flying because of the pure white colour. It rests with wings closed on the body keeping the fore between the hind wings. When resting in this position on the underside of a leaf or on a thin upright stem or a stick, the protective greenish markings on the under-side of wings make it nearly undetectable.

Anapheis aurota aurota (Fabricius)

1793. *Papilio aurota*, FABRICIUS, *Ent. Syst.*, (3) I: 197.
1939. *Anapheis aurota aurota*, TALBOT, *Fauna Brit. India*, (2nd ed.), I: 380, fig. 140 ♂.

Common name.—This butterfly is commonly known as the 'pioneer'.

Distribution.—It is found throughout Persia, Arabia to East Africa and a straggler has been recorded from Great Nicobar. The butterfly is found throughout India except Assam. It is common in the Himalayas from Kashmir to Sikkim and throughout the plains of southern India. In the Nilgiris it is found upto 8,000 feet. In Bannu (N. W. F. P.) it occurs during April, May, November and December. At Mussoorie it is found during May, August and September. At Delhi it has been collected from March to May and August to December. It is rare during January.

Larval food-plants.—The larvae feed on leaves of *Capparis pyrifolia, Capparis aphylla, Capparis sepiaria, Capparis heyneana, Capparis horrida, Cadaba indica* and *Maerua arenaria.*

Early stages and habits.—Eggs are white when fresh, turning orange with age. They are laid in batches of 200 or so, on the tender shoots or the undersides of young leaves. Caterpillars in earlier stages feed gregariously and separately in the grown up stages. The full-grown larva is greenish-ochre. Pupation takes place indiscriminately on the upper-side or under-side of a leaf or on tree trunk; often in groups. The pupa is generally green with a faint supraspiracular band. It has been observed that the females emerge before the males.

The butterfly is fairly strong on wings and generally shows partiality to open places and sun shine. It does not rise very high and usually rests on the ground with wings closed over its back. In dull weather, as usual, it is not so active and rests with upper wings drawn between the hind ones. When disturbed while busy sucking flowers it takes to a quick flight for a short distance. Adults generally sip nectar from flowers of *Cajanus cajan* and *Tribulus terristris.*

Appias libythea libythea (Fabricius)

1775. *Papilio libythea*, Fabricius. *Syst. Ent.*, p. 471.
1939. *Appias libythea libythea*, Talbot, *Fauna Brit. India* (2nd ed.) I. 394, fig. 145♂ ♀.

Common name.—This butterfly is commonly known as the 'striped albatross .

Distribution.—It has been recorded from Ceylon. In India it is found in the Punjab, United Provinces (Mussoorie), plains of Bengal, Orissa and western and southern parts of the country in small numbers. At Bombay it is found during April and May. At Delhi it is available during August only.

Larval food-plants.—Caterpillars feed on leaves of *Crataeva religiosa, Capparis sepiaria* and *Capparis horrida.*

Early stages and habits.—Eggs when fresh are pearl white but turn orange with age. They are laid singly on young shoots or upper surface of leaves. The full-grown larva is light yellowish-green and is phytophagus. The pupa is light green often with brownish shade. Pupation takes place on leaf or branch.

The butterfly is a strong and quick flier. It flies fairly straight 10 to 15 feet high, sometimes taking brisk turns and generally rests on high bushes. It likes open and sunny places. When at rest, forewings are sometimes drawn between the hinder ones. Adults are fond of sipping from the flowers of *Tribulus terristris.*

Appias albina darada (C. & R. Felder)

1865. *Pieris darada*, C & R Felder. *Reise Novara, etc., Lep.* 2: 166

1939. *Appias albina darada.* TALBOT, *Fauna Brit. India.* (2nd ed.) I: 401, fig. 147 ♂ ♀.

Common name.—This butterfly is commonly known as the 'common albatross'.

Distribution.—It has been recorded from Malacca, Sumatra, Borneo, Java, Philippines, Burma, the Andamans and Ceylon. In India the butterfly is found in Bengal, the western and southern India, Gujerat, Poona, Kanara, Travancore and hills of Assam. It has been recorded upto 4,000 feet in Sikkim and it is common in Coorg. At Delhi the butterfly is rare and is generally found during August.

Larval food-plants and early stages of the butterfly have not been investigated.

The butterfly is seldom found in gardens and places having thick growth and shady trees. While in sportive mood it generally rests on the ground and when disturbed takes to short flights.

Catopsilia crocale crocale. (Cramer)

1775. *Papilio crocale* CRAMER. *Pap. Exot.*, I: 87. Pl. LV. fig. C. D.(♀).
1939. *Catopsilia crocale crocale* TALBOT. *Fauna Brit. India*, (2nd ed.) I: 492.

Common name.—This butterfly is commonly known as the 'common emigrant'.

Distribution.—It has been recorded from Thailand (Siam), China, from Malaya to Australia, Ceylon, Burma, the Philippines, Borneo, Sumatra, Java and Andaman Islands where it is known to be rare. In India it is one of the commonest butterflies except in desert tracts. In places, with heavy rain fall, where vegetation is exuberant, the adults are exceedingly numerous. At Delhi the butterfly is abundantly found from August to October, *i.e.*, just after the rainy season. It is generally found from February to May and July to November.

Larval food-plants.—Caterpillars feed on leaves of several leguminous plants like *Cassia fistula*, *Cassia tora*, *Bauhinia racemosa* and *Butea frondosa;* the favourite, however, is *Cassia siamea*.

Early stages and habits.—The eggs which are white at first and yellow later, are laid singly on fresh shoots or leaves. The full-grown larva is bright green with a dark dorsal line and a spiracular broad line suffused with yellow on segments 2 to 5. It feeds on leaves or tender shoots. When disturbed, it jerks itself up and jumps a few inches and also exudes a strong-smelling liquid from its mouth. The pupa is green with a slight ventral wing buldge tail suspension and conical snout. Pupation generally takes place on petiole.

The butterfly settles in crowds on damp sand or forest paths. It usually flies fast taking a straight course, with long up-and-down curves not high from the ground; during courtship it rises 20 to 30 feet above the ground. It is capable of covering long distances in continuous flight. It generally rests on the underside of leaves with the wings closely folded on its back. Adults are fond of sipping nectar from flowers of cotton, lucerne, *Hibiscus rosasinensis*, *Carissa spinarum*, *Lantana camara*, *Lantana sellowiana*, *Hamelia* sp., *Jatropha panduræ-*

folia, Euphorbia pulcherrima, Conyza ambigua, Lagersromia indica, Buddleia lindleyana, Bougainvellea spp. and pomegranate.

Catopsilia pomona (Fabricius)

1775. *Papilio pomona* FABRICIUS. *Syst. Ent.*, p. 479.
1939. *Catopsilia pomona* TALBOT, *Fauna Brit. India*, (2nd ed.), I: 493

Common name.—This butterfly is commonly known as the 'lemon emigrant'.

Distribution.—It is known from Ceylon, Burma, Andaman and Nicobar Islands, South China to Solomon Islands and Australia It is common throughout India. At Delhi it is generally seen flying during July and August.

Larval food-plants.—Caterpillars feed on leaves of *Cassia fistula.*

Early stages and habits.—In the mode of ovi position and colour, eggs resemble those of the preceding species. The full-grown larva is generally green having a round head, with clypeus edged with brown. Pupa differs from that of the preceding species in having dorsal line of thorax, parallel to the body axis for two-thirds of its length.

The butterfly is a quick flier like the preceding species and keeps mostly confined to gardens when not migrating in swarms. It has a swooping flight and closes its wings completely between the strokes. Adults are fond of sipping nectar from flowers of pomegranate, *Lantana camara, Lantana sellowiana, Buddleia lindleyana, Jatropha panduraefolia* and *Russellia juncea.*

Catopsilia pyranthe pyranthe (Linnaeus)

1758. *Papilio pyranthe* LINNAEUS, *Systema Naturae*, ed. 10 : 469.
1939. *Catopsilia pyranthe pyranthe* TALBOT, *Fauna Brit. India*, (2nd ed.), I: 497, fig. 168 b. ♀.

Common name.—This butterfly is commonly known as the 'mottled emigrant'.

Distribution.—It is known from Burma, China, in the east as far as Australia southwards, Ceylon, Thailand (Siam), Annam, Malaya Peninsula, Sumatra, Java, Borneo, Formosa, Hainan and Andamans. It is found almost all over India, and has so far been recorded above 7,000 feet high from sea level. It is found at Mussoorie, Peshawar and Kumaon from June to October. At Delhi it is found throughout the year and is one of the commonest of butterflies. It is very active during September and October after rainy season.

Larval food-plants.—Caterpillars feed on leaves of almost all species of *Cassia*, especially *Cassia occidentalis, Cassia fistula, Cassia ophora* var. *purpurea, Cassia tora, Cassia auriculata, Cassia longifolia,* and *Sesbania aegyptiaca.* It has been reared at Pusa on *Sesbania* flowers.

Early stages and habits.—The pinkish-white spindle-shaped eggs are laid singly on tender shoots. The larvae are very much like those of *crocale.* The pupa is dark green, lighter on the ventral side. During June and September life-cycle is completed in about twenty days.

Adult of *Catopsilia pyranthe* is usually smaller in size than that of *C. crocale* and occurs abundantly in forested and cultivated regions both on hills and plains. It is common in gardens also. It is more brisk and a powerful flier than other *Catopsilia* spp. It is also relatively active during sunny weather covering long distances in a single flight. It usually flies straight but sometimes in an undulating manner also. The adults are found sipping nectar from flowers of *Medicago sativa, Punica granatum, Lantana indica, Boerhaavia repanda, Abutilon indicum, Tagetes erecta, Cajanus cajan, Sesbania sp.* and *Momordica charantia.* As a rule, it is not a pest, but in larval stage it may feed and damage *Sesbania* and *Cassia* spp.

Eurema brigitta rubella (Wallace)

1867. *Terias rubella* WALLACE, *Tran. ent. Soc. London*, (3). **4**, (3) : 323.
1939. *Eurema brigitta rubella* TALBOT, *Fauna Brit. India*, (2nd ed.) **1** : 515 fig. 171. ♂.

Common name.—This butterfly is commonly known as the 'small grass yellow'.

Distribution.—It is known from Ceylon, Burma, and Nicobar Islands extending to south China. It is common all over India, in plains as well as in Kumaon hills (4,000 feet high) and in the Himalayas from Kangra and Simla to Bhutan. At Mussoorie it is common during May, June and from August to October. It is common in Kanara during dry weather. At Delhi the butterfly is seen flying during April and it is quite common from September to November.

Larval food-plants.—Caterpillars feed on leaves of *Cassia kleinii.*

Early stages and habits.—Eggs are laid singly on the upper side of leaves and often on young leaf buds. The grass-green larva usually feeds on the upper-side of leaves. The pupa is usually green with a white spiracular band, and pink and wrinkled snout.

The butterfly is weak in flight which is of the usual type but not continuous. It usually flies close to the ground over low bushes and rests amongst vegetation growing underneath plants. Adults are found sipping nectar from flowers of prostrate and low growing plants like vetches.

Eurema laeta laeta (Boisduval)

1836. *Terias laeta* BOISDUVAL, *Spec. Gen. Lep.* **1** : 674.
1939. *Eurema laeta laeta* TALBOT, *Fauna Brit. India*, (2nd ed.) **1**. 517, fig. 172.

Common name.—This butterfly is commonly known as the 'spotless grass yellow'.

Distribution.—This butterfly is known from Ceylon and Burma. In India it is common in the Himalayas from the borders of Afghanistan to Bhutan, throughout the Punjab, Ahmadnagar, Karachi, Poona, Bombay in the west, Nilgiri and Anamalai hills in the south and in Assam. At Delhi it is usually found during May and September and October but is not a common butterfly.

Larval food-plants and early stages have not been investigated.

The butterfly is weak in flight and does not flutter its wings as much as other species of the genus. It neither flies high and nor over long distances. It, rather, keeps to places having thick growth, grass or weeds being amongst the favourite ones. It closes its wings over its back immediately it settles, their colour blending with the surroundings and rendering its detection difficult. The adults are generally found sipping nectar from flowers of *Tribulus terristris* and *Boerhaavia repanda.*

Seasonal dimorphim is so strongly marked that the two forms *laeta* and *venata* were considered to be distinct species until Mosse (1931)[2] proved them to be conspecific.

Eurema hacabe contubernalis (Moore)

1886. *Terias contubernalis* MOORE. *J. Linn. Soc London* (*Zool.*) **21** : 46.
1939. *Eurema hacabe contubernalis* TALBOT, *Fauna Brit. India.* (2nd Ed.) **1** : 527, fig. 177.

Common name.—This butterfly is commonly known as the 'common grass yellow'.

Distribution.—It is known from Thailand (Siam), China, Malayan sub-region and to the west into parts of the Ethopian region; Burma and Ceylon. It is very common throughout India. At Delhi it is met with throughout the year, common from July to October, and rare during December and January.

Larval food-plants.—Caterpillars feed on leaves of various species of *Sesbania* and *Cassia.* It has been recorded feeding commonly on *Sesbania* sp. at Poona and Duars; in Coimbatore and Cuttack on *S. aegyptiaca;* in Pusa on *Cassia tora;* in Rangpur on *Sesbania aculeata;* other plants are *Albizzia, sp.*, *Wagatea, sp.*, *Acacia, sp.*, *Caesalpinia oriaria, Pithecolobium dulce, Trigonella foenumgraecum.*

Early stages and habits.—Spindle-shaped eggs are laid singly on the upper-side of leaves. When fresh the eggs are white but turn yellow with age. The full-grown larva is dark green and laterally glaucous. Pupation takes place on the plant. There are at least four broods in a year, but there may be as many as twelve under favourable conditions.

The butterfly remains on wing for a considerably long time, sometimes rising about 20 feet high. It is a better and stronger flier than other species of the genus. In gardens it likes open and sunny places. It frequents damp places during hot months of the year. It is equally abundant in extensive shady forests in hills and in open hot plains. Copulation takes place for over an hour, during which time the male is an inactive partner and when disturbed it is carried by female *in situ* sheltering amongst leaves of low-growing plants. It goes freely to sip nectar from the flowers of *Tribulus terristris, Boerhaavia repanda, Jatropha panduraefolia, Carissa spinarum, Lantana indica, Euphorbia geniculata* and *Gomphrema globosa.*

Colias electo fieldi Menetries

1855. *Colias fieldi* MENETRIES, *Enum. Corp. Anim. Mus. Petr.*, **1** : 79 pl. 1, fig. 5 ♂
1939. *Colias electo fieldi* TALBOT, *Fauna Brit. India,* (2nd ed.), **1** : 562.

Common name.—This butterfly is commonly known as the 'dark clouded yellow'.

Distribution.—It is known from Upper Burma and China. In India it is found in the Himalayas from Chitral to Sikkim and Bhutan at a level of

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[2] Mosse, A. H. E., J. Bombay Nat. Hist. Soc., **34**: 1094—5.

2,500 to 14,000 feet extending upto Assam. It is common in Baluchistan, Chitral, Kumaon, North Punjab and rare in the United Provinces. At Delhi the butterfly is rarely found during November and December.

Larval food-plants and early stages are not known.

The adult is a fairly quick flier and generally flies in open fields. When at rest usually it keeps its wings spread over the body in V shape. Due to its rarity, other habits of the butterfly have not been studied

Ixias marianne (Cramer)

1779. *Papilio marianne* CRAMER, *Pap. Exot*. **3**: 41, pl 217 figs C. D. ♀, E. ♂
1939. *Ixias marianne* TALBOT, *Fauna Brit. India*, (2nd ed.) **I** 440, fig. 155 ♂

Common name—This butterfly is commonly known as the 'white orange tip'.

Distribution.—It occurs in Ceylon; in India it is common in Mahableshwar, the Punjab and Kumaon, N. W. Himalayas, Bengal and Central India. At Delhi the butterfly is very common throughout the year but less so during December and January.

Larval food-plants.—Caterpillars feed on leaves of ***Capparis sepiaria***, ***Capparis divaricata***, ***Capparis aphylla*** and ***Capparis grandis***.

Early stages and habits—Eggs are laid singly on leaves, sometimes on thorns as well. They are, when fresh, light yellow and attain flesh-colour with age and are bottle-shaped with a very short neck. The larva which is grass-green generally feeds on the upper-side of leaves. The pupa is green, marked with dark reddish-brown. Pupation takes place on the under surface of leaf or its stalk.

The adult likes open places and is generally found in large numbers about ***Carissa spinarum*** and ***Capparis sepiaria***, when in flowers. It is quick in its movements and performs short flights 10 to 15 yards long and about 15 feet high but not in a straight line. Before resting on flowers, adult reconnoiters the plant thoroughly well. It evades capture even if it may have to pass through thorny plants and bushes. Males are found more in number than females. Copulation generally takes place during rainy season i.e., July and August. The butterfly is fond of visiting flowers of ***Petunia violacea***, ***Heliotropium undulatum***, ***Capparis aphylla***, ***Capparis sepiaria***, ***Carissa spinarum***, ***Cosmea klondyke***, ***Boerhaavia repanda***, ***Tagetes erecta***, ***Lantana indica***, ***Zizyphus*** spp. and cotton.

Ixias pyrene kausala Moore

1877 *Ixias kausala* MOORE, *Ann. Mag. Nat. Hist.* (**4**), 20. 49.
1939. *Ixias pyrene kausala* TALBOT, *Fauna Brit. India*, (2nd ed) **I**. 446.

Common name.—This butterfly is commonly known as the 'yellow tip'.

Distribution.—It is known from China and the Malayan sub-region. It is common throughout India except the desert regions. At Miramshah (Tochi Valley) the butterfly is common from February to April and also during September. At Peshawar it is found in April. At Delhi it is found throughout the year, except during December and January.

Larval food-plants —Caterpillars feed on leaves of *Capparis sepiaria.*

Early stages and habits.—Eggs when fresh are pearl-white and shiny and attain pale cream colour, with pink blotches and spots with age. The full grown larva is generally of dark grass-green. The pupa is light green. Pupation takes place in a secluded place where the pupa cannot be easily seen.

The butterfly is a swift flier and generally sports in the sun, and is found hovering over green vegetation, rarely rising above 10 to 15 feet above from the ground. It flies more or less in a straight line and rests on leaves of bushes and trees after long intervals. When resting on a half withered leaf of *Adhatoda vasica* it is difficult to detect its presence due to the blending of its colour with that of the leaf. In the evening or dull weather it retires to places low down among leaves in the thickets, which characterise its haunts. It is reported to manifest a particular liking for surroundings where prickly pear (*Opuntia dillenii)* abounds. It is fond of sipping nectar from flowers of *Lantana indica, Zizyphus numularia, Gomphrena globosa, Boerhaavia repanda, Abutilon indicum, Tagetes erecta* and *Punica granatum.* Piele (1937)[3] observed it on *Chrysanthemum* and wall flowers.

Colotis calais amata (Fabricius)

1775. *Papilio amata* FABRICIUS, *Syst. Ent*, p. 476.
1939. *Colotis calais amata* TALBOT, *Fauna Brit. India.* (2nd ed.) I: 454, fig. 158.

Common name.—This butterfly is commonly known as the 'small salmon arab'.

Distribution.—It is known from Ceylon, Aden, Arabia, Persia, Syria, Madgascar and Tropical Africa. In India it is found in Bombay, Sind, Baluchistan, the United Provinces and the Punjab. At Delhi it is available throughout the year except January and December; it is, however, common from June to October.

Larval food-plants.—Caterpillars feed on leaves of *Salvadora persica, Salvadora oleoides* and *Azima tetracantha.*

Early stages and habits.—Eggs generally laid in batches of 50 to 60, are white when fresh and yellow later. The full-grown larvae are generally bright grass-green and feed gregariously first on the epidermis and gradually on the entire leaf. The pupa is generally green.

The adult is not a strong flier. It keeps always near the ground though sometimes male adult rises to the tops of the food-plants in search of the female. It flies with quick fluttering of wings generally straight and parallel to the ground. On being disturbed it usually goes under thick bushes. Like other species of the genus it likes open places but prefers spots where *Boerhaavia repanda* grows in abundance. It is fond of visiting flowers of *Lantana indica, Boerhaavia repanda, Gomphrena globosa* and *Tagetes erecta.*

Colotis vestalis vestalis (Butler)

1876. *Teracolus vestalis* BUTLER, *Proc. zool. Soc. London*, p. 135, pl. 7, fig. 10 ♂
1939. *Colotis vestalis vestalis* TALBOT, *Fauna Brit. India*, (2nd ed.), I : 457, fig. 159.

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[3] Piele H. D., A Guide to collecting butterflies of India.

Common name.—This butterfly is commonly known as the 'white arab'.

Distribution.—It is known from round about the Persian Gulf. In India it is found in Baluchistan, the Punjab, western India, Cutch, Rajputana, Sind, the Central and United Provinces. During April and from July to November it is found in arid regions like Mary-Indus and Tochi valley. At Ajmer it is found during August and September. At Delhi it is available throughout the year except during extreme cold months i.e , December and January while during September and October it is very common.

Larval food-plants —Caterpillars feed on leaves of *Salvadora persica.*

Early stages and habits :—Eggs, laid singly generally on old leaves near the base of the plant, are white when fresh and turn yellowish with age. The larvae are not gregarious in habits like those of *Colotis amata.* The body of the full-grown larva is generally grass-green The colour of the pupa is pinkish. Pupation takes place on the surface of leaves.

The adult butterfly resembles the preceding species in general habits and flights. It generally takes shelter under the lower part of thorny bushes. It usually remains in sunny places along the hedges of gardens but revels on hot days. It is fond of visiting and sucking flowers of *Capparis aphylla, Boerhaavia repanda, Tagetes erecta* and *Tribulus terristris.*

Colotis fausta fausta (Olivier)

1801. *Papilio fausta* OLIVIER, *Voy. L'Emp. Oth., Atlas,* pl. 33, figs 4a & 4b.
1939. *Colotis fausta fausta* TALBOT, *Fauna Brit. India,* (2nd. ed), **1**: 461.

Common name.—This butterfly is commonly known as the 'large salmon arab'.

Distribution.—It is known from Ceylon, Asia Minor, Persia, Egypt, South Arabia, Afganistan. In India it is commonly found in Baluchistan, N.W.F. Province, Sind, the Punjab, Rajputana and South India. In Tochi valley it is found from October to December. At Delhi the butterfly is commonly found from February to March and August to November. It generally abounds in dry and hilly places like the Viceroy's reserve forest.

Larval food-plants.—The larvae feed on leaves of *Maerua arenaria.*

Early stages and habits.—Eggs are bottle-shaped and white when fresh and turn yellowish with age. They are laid singly, indiscriminately both on upper and lower surfaces of leaves and in quick succession. The full-grown larva is generally rich green and blends well with the colour of leaves, thereby becoming difficult of detection. The pupa is usually of livid bone-colour and sometimes bright green.

The butterfly likes sunny, stony and open places where *Capparis aphylla* grows in abundance. It does not exist in damp places and in localities with heavy rainfall. For the aforesaid reasons it is one of the characteristic butterflies of the plains and desert regions. It performs short flights and does not, even on disturbance, take long flight. The butterfly generally rests on the ground with the wings closed over its back and the front ones drawn between the hind ones. It is more active in the forenoon than in the afternoon It can easily be collected when resting on the ground. It is fond of visiting flowers of *Capparis aphylla, Capparis sepiaria* and *Hibiscus micranthus.*

Colotis etrida etrida (Boisduval)

1836. *Anthocharis etrida* BOISDUVAL, *Spec. Gen. Lep.* I: 576.
1939. *Colotis etrida etrida* TALBOT, *Fauna Brit. India*, (2nd ed.), I : 465.

Common name.—This butterfly is commonly known as the 'little orangetip'.

Distribution :—It is common in Baluchistan, Kashmir, the outer ranges of the Himalayas, throughout Peninsular India except Bengal. In Peshawar valley it is found during February, April and October. In the United Provinces, (Fatehgarh) it is fairly common during February, July and from October to December. At Delhi the butterfly is available throughout the year except during December and January, but is common from June to October.

Larval food-plants.—Caterpillars feed on leaves of *Cadaba indica* and *Capparis aphylla.*

Early stages and habits :—Eggs are yellowish when fresh but become reddish later. They are laid singly on young shoots, on flower buds, withered twig, stalk or underside of leaf. The pupa is generally pinkish but when formed among leaves it develops a strong green colour. Pupation takes place on the under surface of leaf near the ground.

The adult is mostly present in open places amongst thorny bushes. It is a fairly strong flier seldom rising above ground. It is found visiting flowers of *Capparis aphylla* and *Tagetes erecta* for nectar.

Colotis danae danae (Fabricius)

1775. *Papilio danae* FABRICIUS, *Syst. Ent.* p. 476.
1939 *Colotis danae danae* TALBOT, *Fauna Brit. India*, (2nd ed) I : 469.

Common name.—This butterfly is commonly known as the 'crimson tip'.

Distribution.—It is known from Ceylon, and Peninsuiar India *i.e.*, southern India and Central Provinces. It is commonly found in Palni hills from April to June and August to October. At Delhi the butterfly is rarer than other species of the genus, and is available only during the summer months, May and June.

Larval food-plants.—Caterpillars feed on leaves of *Cadaba indica, Capparis sepiaria, Capparis divaricata* and *Maerua arenaria.*

Early stages and habits.—Eggs are generally laid singly on old leaves or their stalks. The full-grown larva is usually glaucous green. It changes its colour to pink before pupation. The pupa is green or of bone-colour. Pupal period is about a week.

This butterfly flies straight but is weak in flight as compared to other butterflies of the genus, with the exception of the male of *Colotis fausta.* It flies always near the ground and is never found in jungles and places with heavy rainfall. Both sexes are found in equal proportion.

Cepora nerissa phryne (Fabricius)

1775. *Papilio phryne* FABRICIUS, *Syst. Ent.* p. 471.
1939. *Cepora nerissa phryne* TALBOT, *Fauna Brit. India*, (2nd ed.), I : 364, fig. 136.

Common name.—This butterfly is commonly known as the 'common gull'.

Distribution.—It is known from upper and lower Burma, Thailand (Siam) and China. In India it is commonly found in Nepal, Sikkim, Bhutan, Bengal and Assam. At Delhi it is available from May to November and is rare during winter and spring.

Larval food-plants.—Caterpillars feed on leaves of *Capparis aphylla, Capparis sepiaria, Capparis heyneana* and *Capparis horrida.*

Early stages and habits.—Eggs are laid indiscriminately on different parts of the plant. The full-grown larva is dark bluish-green dorsally and venterally light greyish-green. Body of the pupa is grass-green having the wing pads and ventral side greenish white. Pupal period is known to be about 10 days.

The adult is a fairly strong flier and generally takes a straight course. It is fond of sun and likes open places even in gardens. When resting on the ground it very often keeps its wings half open on the sides as if basking in the sun. It rises hardly a few feet from the ground when it is in a sportive flight. It is frequently found visiting flowers of *Lantana indica, Capparis sepiaria, Carissa spinarum, Polygonum barbatum, Euphorbia geniculata, Boerhaavia repanda, Gomphrena globosa* and *Tagetes erecta.*

ERIOPHYES PROSOPIDIS, SP. NOV., A NEW GALL-FORMING MITE FROM INDIA

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(Communicated by M. S. Mani).

I recently collected specimens of *Eriophyes* Sieb., causing an extremely interesting kind of histioid gall (No. 19) on the inflorescence of *Prosopis spicigera* Linn. at Delhi. The mites attack the young buds and give rise to irregularly globose, often agglomerated, semi-solid, hard galls, about 5 to 30 mm. in diameter The normal floral organs fail to develop.

The mites resemble *Eriophyes acaciae* Nalepa* in general appearance but differ in several essential characters and are described here as a new species under the name *Eriophyes prosopidis.* The measurements are given in microns.

Eriophyes prosopidis, sp. nov.

Female and male.—Body reddish, cylindrical, somewhat narrow posteriorly, length 120-165, breadth 36-37·5 at the broadest point in the middle of the body. Cephalothorax length 30, breadth about 25, slightly projecting over the rostrum, with about 6 longitudinal striated sculptures. Chelicerae somewhat shorter than the maxillae. Thoracic bristles inserted at the anterolateral edges of the cephalothorax, stout and short, directed forwards, with basal tubercles very distinct. First pair of legs 30-32 long; second 22-25, third segment longest; pectinate claw 15, setaceous claw 21, with 7 feathers in the pectinate claw; first pair of coxal bristle 30, second shorter, third longest. Sternal ridge prominent. Abdominal rings about 80 in number. Epigynium length to width in the ratio of 7:8, flaps 9; genital bristles 5. Anal bristles stout, pointed, 30. Subapical seta of leg on the last but one segment about six times the length of the segment. Telson 7·5 long and 3·5 broad. Caudal setae about as long as the body. Lateral setae shorter than the ventrals. First pair of ventral setae half as long as the caudals, fourth pair a little less than one-fourth of the caudals.

Type series.—In spirit with gall No. 19 dissected, in the collections of the Zoological Survey of India, Kaiser Castle, Benares, coll. R. D. Saksena, 20-5-1943, Delhi, from inflorescence galls on *Prosopis spicigera* Linn.

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*Nalepa, A., *Marcellia*, **13**, p. 70 (1914).

DESCRIPTION OF AND BIOLOGICAL NOTES ON A NEW SPECIES OF SYRPHIDAE FROM INDIA

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While studying the unidentified Syrphid material in the Imperial Pusa Collections, I came across a number of specimens of Syrphid flies belonging to the genus *Xanthogramma* (Schiner), having flat broad five-segmented abdomen and conspicuous orange spots on the pleuron. Lindner (1932) described a number of species of the genus *Xanthogramma* from the Palearctic region with none of which these specimens before me agree. Brunetti (1923) described *Xanthogramma citrinum* Brun. from India, and there is no other record of any other species of this genus from this region. The present material differs from *X. citrinum* Brun. in several important respects and is therefore described as a new species under the name *Xanthogramma pruthii*, sp. nov.

Measurements of the various parts of the body (in mm.) of *Xanthogrmma pruthii*, sp. nov. (average of six specimens)

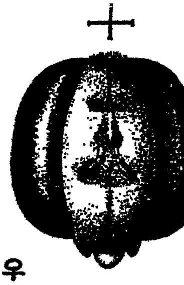
Sex.	Length from frons to tip of abdomen.	Width of head.	Width of thorax.	Width of abdomen.	Length of wings.
Female	11·25	3·75	3·5	3·8	9·5
Male	12	4	3·75	4	10·6

In general, the male is distinguished from the female by its larger size, the unequal facets of the contiguous compound eyes and the absence of black as well as of faint black marks on the vertex and frons; it is also more hairy.

Head (Fig. 1). Face yellow except rim of epistome, bases of antennae and central knob of face. Compound eyes deep brown in both the sexes and having a golden hue in certain lights. Eyes separated at vertex region by a distance of about 1 mm. A small vertical faint-black triangle divided by a vertical line present on the frons. First and second joints of the antenna orange ventrally and brown dorsally. Arista brown. Pale yellow hairs sparsely on the post ocellar region extending up to ocelli. In the male the ommatidia of the front and the upper regions bigger than the hind and lower regions; third joint of the antenna black dorsally, and the pale yellow hairs of the post ocellar region more compact. Proboscis dark brown in both sexes.

Thorax (fig. 2 & 3). Black with a bluish tinge in certain lights. A narrow yellow band (fig. 3) at the sides of thorax extending from the humeri to scutellum. Pleuron slate-coloured, with one lime-yellow spot on the mesopleuron, one on the pteropleuron and one orange spot below the wings (Fig. 3). Scutellum lemon-yellow, dark anteriorly with grey pubescence. In the male more hairy and with a pale yellow pubescence.

Abdomen (Fig. 2). Deep brown to shining black with a pair of orange spots dorsally on each of the 2nd, 3rd, 4th and the 5th segments; spots of the 3rd segment being the largest and those of the 5th the smallest. Distal margin of the 2nd and 3rd segment has a thin and that of the 4th and the 5th a thick orange border. Spots on the 2nd segment curved anteriorly and continued on to lateral margin of the segment. Spots on the 3rd and 4th segment not continued on to the lateral margins of the segment. The triangular small spots on the 5th segment also directed anteriorly. No spots on any segment meeting the other at the centre of the segment.



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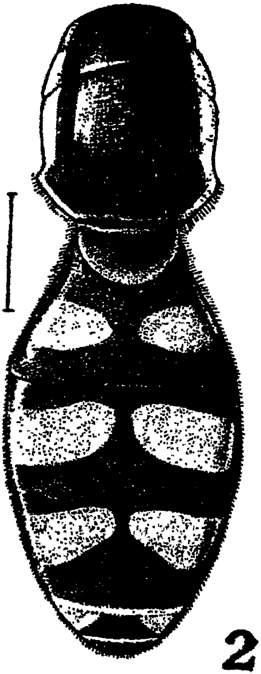

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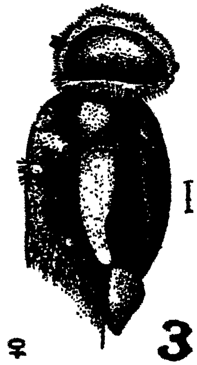

3

Ventral surface of each abdominal segment orange with a short transverse black band at the posterior border.

Legs. Except for the following variations all the legs orange coloured. Coxae and trochanters of all legs, basal three fifths of the femora of hind leg, basal half femora of middle and basal one-third of femora of hind legs deep brown to blackish in both the sexes. Tibia in all legs covered dorsally by a dense layer of dark hairs. The first tarsal joint of hind legs as long as all the joints together. Claws deep black at the tips.

Wings. Greyish-yellow Knob of halters orange, stalk deep brown.

Holotype female:—P. B. Mukerjee coll. 21. iii. 1938 on carrot at Delhi; *allotype* male:—P B. Mukerjee coll. 24. iii 1938 on linseed at Delhi, pinned, in the Imperial Pusa Collection, Laboratory of the Imperial Entomologist, New Delhi.

Other pinned specimens of this species:—P. B. Mukerjee coll. 16. ii. 1938 on berseem at Delhi, K. R. Khan coll. 24. ii. 1938 on linseed at Delhi, H. L. Bhatia coll. December 1940 at Turbot in Mekran.

BIOLOGICAL NOTES

The eggs laid between groups of *Myzus persicae* (Sulz.) were collected from the under surfaces of the leaves of *Luffa graveolens* Roxb. in November 1941. They are elliptical in shape and about a millimeter in length.

The maggots hatched in about three to four days time. Freshly hatched maggots are brownish, tapering at one end, and measure about one millimeter in length. Small tubercular spines are present on all the segments and the last segment bears two elongate digits on which are situated the openings of the spiracles. There is a pair of suckers on the ventral side of the last segment. These are fixed to the substratum and the anterior end of the maggot then moves in all directions. The maggots are very voracious feeders. An aphid is bodily lifted from the leaf, held aloft by the mouth in the air and then sucked dry. When very hungry, they can suck about two aphids a minute. They have been observed to suck about 484 aphids from a leaf at a stretch within about four hours.

As the maggot advances in age, the tubercles increase in size, the posterior digits shorten in length and a faint yellow streak is formed mid-dorsally. The full-grown maggot is about 13 mm. in length, 2 mm. in width, and is deep brown. The maggot pupated in about 12 to 15 days. The pupa is greenish-brown almost barrel-shaped, measures from 7-8 mm. in length, and is attached to the leaf by a thin silken pellet. There is a central whitish streak on one side. The fly emerges within 14 to 17 days. The entire life-history was completed at Delhi within 29 to 36 days, during November to January. The average maximum and minimum temperatures for November, December 1941 and January 1942 were 88°·21F—51°·82F, 75°·9F—46°·0F, 68°·76—41°·2. The average humidity percentage for these three months was 44·36%. 66 5%, and 81%.

The fly is very active and lived on honey solution for 25 days. Copulation was seen to take place on the wing after the 7th day of emergence from the pupa.

ACKNOWLEDGMENTS

I have great pleasure in thanking Dr. H. S. Pruthi, the Imperial Entomologist, for facilities and Mr. Hindlekar, the staff artist, for the drawings.

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Explanations of Figures (natural size indicated in each figure)

Fig. 1. The head.
Fig. 2. The thorax and the abdomen.
Fig. 3. The pleuron with the yellow streak and the yellow spots.

THE EFFECTS OF CONSERVING HEALTHY AND PARASITISED EGGS OF *PYRILLA spp.*, IN WIRE GAUZE CAGES ON THE POPULATION OF THE PEST AND ITS PARASITES

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1. INTRODUCTION

Of the various possible measures of controlling the sugarcane *Pyrilla*, collection and destruction of egg-masses is generally widely practised. This method, unless carried out carefully, may do more harm than good, because practically in all localities where *Pyrilla* occurs, its eggs are parasitised by one or more of the following species: *Tetrastichus pyrillae* Crawf., *Ooencyrtus pyrillae* Crawf., *Ageniaspis pyrillae* Mani, *Cheiloneurus pyrillae* Mani and *Ooencyrtus papilionus* Ashm. It is obvious from this that an indiscriminate destruction of egg masses would certainly result in the destruction of thousands of these useful parasites. It has been found, for instance, that the three parasites *Ageniaspis pyrillae* Mani, *Tetrastichus pyrillae* Crawf., and *Cheiloneurus pyrillae* Mani breed in regular sequence in the egg-masses of the post-monsoon brood of *Pyrilla* in several parts of Northern India. On some occasions over 60 per cent of *Pyrilla* eggs were thus found parasitised and a thoughtless and routine collection and destruction of egg masses, without reference to the parasite factor, would only end in the simultaneous destruction of several hundreds of parasites, which if undisturbed, may bring the pest under control under natural conditions.

2. EGG CONSERVATION

If, however, the percentage of parasitised eggs is so low as to make it almost impossible for the parasites to overtake the pest before the damage is inflicted and there appears to be no other way out of the situation but to recommend the removal of egg masses, the entomologist recommending it should qualify his recommendation with the injunction that all egg masses removed should not be destroyed but conserved in special receptacles, which, while retaining within it the *Pyrilla* nymphs emerging from healthy eggs would permit the parasites emerging from parasitised eggs to get into the field and propagate their species. As *Pyrilla* nymphs confined within the receptacles would sooner or later perish of starvation, a farmer who adopts this method would not only realise his objective of reducing the population of *Pyrilla* but would also be helping the parasites to steadily gain ground and eventually have the supremacy of the field The method is neither wholly mechanical nor purely biological but a healthy combination of both, in which the mechanical process of egg collection and conservation so tilts the balance of power in favour of the parasites as to ultimately bring about a biological control of the pest.

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* As announced earlier, the Editorial Board regrets that Dr. J. A. Muliyil passed away before this paper could be sent to the press.

Small rectangular wooden cages of the type devised and used by the writers in the experiments conducted by them at Palhera Farm (near Meerut Cantonment) in 1938. could be used with advantage by anyone who would like to test the efficacy of such a method of control. The cage referred to is nothing more than a miniature meat safe measuring 12" × 10" × 10" with wire gauze panels, the gauze having 900 meshes per square inch. Such a gauze, while preventing *Pyrilla* nymphs from getting out would enable the parasites to fly out of the cage. One of the panels is provided with hinges to serve as a door and a central ply wood partition, dividing the cage into an upper and a lower half considerably reduces the pressure on the lower layers of egg masses when the cage is filled.

3. TECHNIQUE OF EGG CONSERVATION

The modus operandi' is very simple. *Pyrilla* egg masses with their white fluffy covering are conspicuous objects in *Pyrilla* infested plots and it needs no search to locate them All egg masses whether healthy or parasitised are removed from the plants and put into the cages. To avoid congestion and to enable the emerging parasites to get out, too tight a packing of the cages is avoided. If *Pyrilla* has started depositing its eggs inside leaf sheaths, they are also removed and conserved in the cages. When all egg masses have been removed and the cages are well stocked, they are taken and hung up in various parts of the infested plot so that there could be as uniform a distribution as possible of the emerging parasites over the affected area. Parasites would start emerging in the cages in the sequence in which they were parasitised in the field. Emergence would start on the day the cages are hung up and would continue for a period of ten or twelve days by which time parasites, even from eggs parasitised on the date of collection, would have fully developed. After this period, if the operator is sure that all *Pyrilla* nymphs within the cage are dead, the contents of the cage are thrown out and the whole process is repeated again with egg masses collected afresh. The percentage of parasitised eggs before starting the control measure could be ascertained by examining a randomised collection of egg masses on the day of starting the control measure and similar examinations made while the control measure is being applied will reveal the progress of parasite activity.

4. EXPERIMENTAL EVIDENCE

By using cages of the type described in this note, the writers had occasion to test the efficacy of this control measure and they found that in the course of ten days the percentage of parasitised eggs in leaf sheaths rose from 25·7 to 59·8 and that on leaves rose from 68 6 to 73·4. A month later, while the percentage of parasitised eggs in leaf sheaths showed no appreciable change, the percentage of parasitised eggs on leaves dropped from 73·4 to 63·3. This drop is easily explained ; as with the approach of winter, *Tetrastichus pyrillae* Crawf., the parasite which is mainly responsible for attacking *Pyrilla* eggs laid on leaves, gradually vanishes from the field and its place is taken by *Cheiloneurus pyrillae* Mani, the parasite which prefers eggs laid in leaf sheaths.

5. CONCLUSION

The writers realise that the results of one experiment, however carefully planned out, are insufficient to arrive at any definite conclusion on the value of a particular control measure. They intend repeating this experiment as opportunities present themselves and the purpose of presenting this paper at this stage is to invite those interested in the problem of *Pyrilla* control to put the suggested method to every possible test before it could take its legitimate place in the armoury of the economic entomologist.

APROSTOCETUS KRISHNIERI MANI-AN IMPORTANT INTERNAL PARASITE OF THE AMARANTUS STEM BORING WEEVIL, *HYPOLIXUS TRUNCATULUS* (BOH.) IN SOUTH INDIA.

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Introduction

During investigations on the biology of the cotton stem weevil and its parasites some attention was directed to similar studies on allied weevils. One of the most common and convenient forms among the latter proved to be the Amarantus weevil *Hypolixus truncatulus* (Boh.). This species was extensively used as a convenient laboratory host for breeding many parasites of Pempherulus. Besides, this weevil itself carried a rich and varied parasitic fauna among which a few were found to be common to both the hosts.

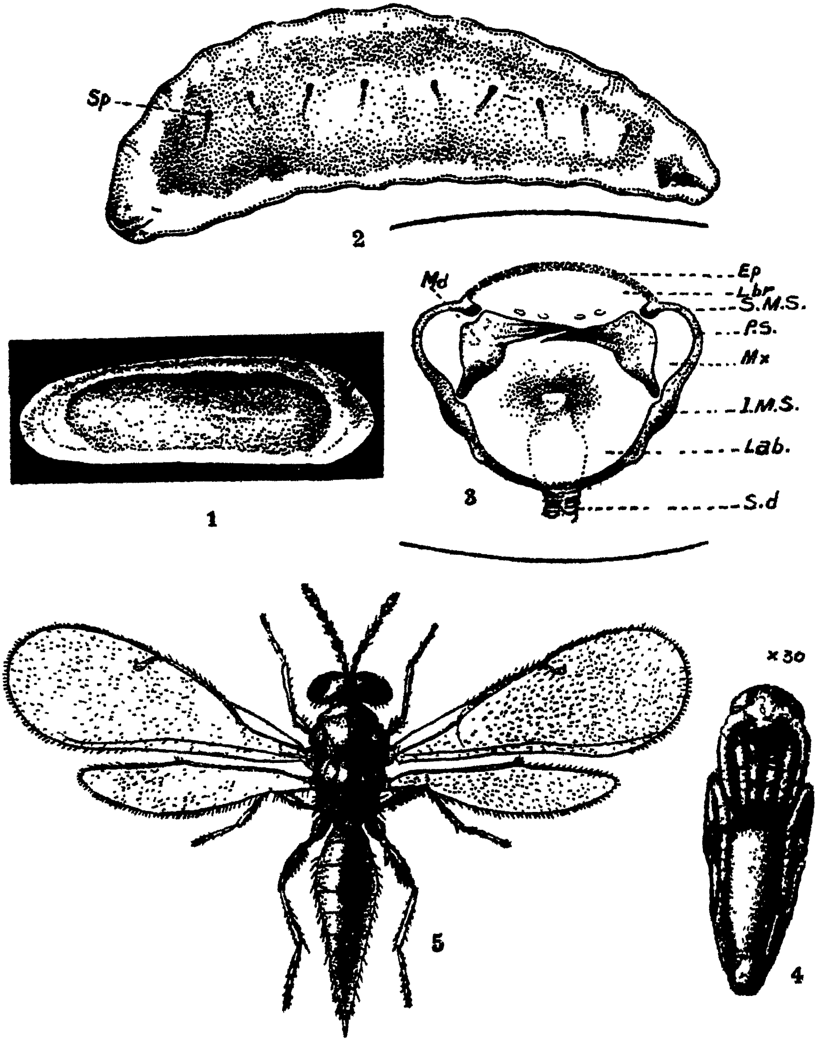
Among nearly a dozen species of parasites attacking the Amarantus weevil, one of the most abundant, effective and interesting forms was a small dark Chalcid, which was later described by Mani (1941) as a new species of *Aprostocetus*. A detailed investigation on the biology and morphology of this insect was commenced towards the close of 1940. The present paper is an attempt to record the results of these studies.

The Parasite

Aprostocetus krishnieri Mani is a common gregarious Chalcid (Eulophidae) occurring as an internal parasite of the grubs of the Amarantus weevil. It occurs abundantly in the environs of Coimbatore and probably also in other parts of south India. The parasite spends its egg-period and major portion of its larval-life within the hoemocoele cavity of the host grub from which it derives its sustenance.

Distribution And Host Records Of The Genus

The genus *Aprostocetus* though not cosmopolitan, has a wide distribution in Europe and America. A few species have been noted in Africa and Japan. Their host range is varied though primarily confined to gall midges. *A. fidius* Gir. is known as a parasite of the gall midge *Jatrophobia brasiliensis* which attacks Cassava in Trinidad (1930). Another species of the genus is an egg parasite of the tree cricket *Oecanthus niveus* in California. *A. roseveari* Fer. has been recorded from a Psyllid in Nigeria (1932). *A. caudatus* Westw. has been noted as a parasite of *Dasyneura alopicuria* in Britain (1933). *A. ciliatus* Nees is mentioned as reared from the gall midge *Rhabdophaga heterobia* in Britain (1935). *A. fukutai* Mima is recorded as a parasite of *Melanauster chinensis* in Formosa. *A. asphidimorphia* (1938) has been noted from a doubtful host. These records indicate that the genus has been known hitherto only from Japan in Asia. Probably *A. krishnieri* forms the first record of the genus in India and is also the first instance of a weevil host.



Figs. 1—5, *Aprostocetus krishnieri* Mani

1. Egg; 2. Full-grown larva; 3. Cephalic skeleton of full-grown larva in ventral view (highly magnified); 4. Pupa; 5. Adult female.

Explanation of lettering:—Ep. Epistoma. Lbr. Labrum. P.S. Pleurostoma. Mx. Maxilla. Md. Mandible. I. M. S. Inferior mandibular strut. S. M. S. Superior mandibular strut. Lab. Labium. S. D. Salivary duct.

TECHNIQUE

As a minute internal parasite, the development of the egg and larval stages was traced from a series of dissections of host grubs collected twice and even thrice a day and a few were reared in cages in the laboratory. The latter process of rearing in laboratory has been very difficult due to rare and occasional ovipositions in captivity. The larvae and eggs were dissected in de Faure's fluid and normal saline solution under a binocular. The stages were fixed and mounted for study and photographic record. The parasite larvae continued to be alive for nearly two days in de Faure's liquid. The measurements were made on freshly dissected specimens. Unparasitised host stages were obtained from rearings in confinement.

THE ADULT

(Mani, 1941—Indian J. Ent., 3, 36). The adult female (figure No. 1) is a minute black insect with a metallic bluish sheen averaging about 2.5 mm. in length. The male is slender with a narrow and short abdomen.

Female dimensions :—

Length—2.3 to 2.7 mm.
Width—0.65 to 0.7 mm.

Male dimensions :—

Length—1.7 to 1.9 mm
Width—0.5 to 0.55 mm.

These insects are somewhat attracted towards day light. When disturbed they hop about for a distance before taking to flight.

Mating :—There is nothing special in their mating habits. The male after sensing the presence of the female sets off in pursuit with the wings and antennae in violent vibration. He mounts on the female quickly when near, with the two anterior pairs of legs clasped round the thorax and the posterior pair round the abdomen. He jumps off if the female is not sufficiently stimulated. Copulation lasts from 10 to 20 seconds, should the female be receptive.

GENERAL BIOLOGY

Attempts to observe the female oviposting in cages or in the field have been unsuccessful. Eggs are laid up to a maximum of 38 in the hoemocoele cavity amidst fat bodies in the early instars of the host grubs. In the example photographed and sketched (in fig. 2 and 3) the eggs were found embedded in the fat bodies which on dissection got detached. The incubation period lasts less than one day probably covering 12 to 16 hours. The newly hatched larvae feed on the fat body. The larva passes through four instars and becomes full-grown in about 5 to 7 days. The host grub appears to be normal and active until the parasite reaches the third stage when the fat body is very nearly consumed and feeding on the other tissues begins. The spiracles are developed and become visible at this stage. By the time the larva attains the fourth stage, the entire contents of the host are consumed leaving only the empty host cuticle which soon gives way exposing the larvae. Immediately, these evacuate the meconium and turn into prepupae which stage lasts from 6 to 8 hours after which they turn into pupae in the larval tunnel of the host grub. The pupae are at first white and turn yellow, brown and finally dark. The adults emerge within 6 to 11 days; the entire life cycle taking 14 to 19 days.

Oviposition:—The eggs are laid in groups from 2 to 5 in the haemocoele cavity of young host grubs ordinarily not older than the third instar. The preferred stage is usually the second instar but eggs may be laid less frequently up to the fourth instar. The eggs are generally lodged in fat bodies but cases where the eggs are free in the body cavity are not uncommon. It is possible in this case that these were detached by teasing. These have been found always in groups or batches suggesting the probability of their having been laid in groups. Probablv each batch is laid in a single thrust though ordinarilv hymenopterous parasites lay only one egg per thrust. In consideration of the fact that a female possesses 30 to 40 eggs in the ovarioles more or less ripening, it is possible that the female deposits all avilable eggs in the course of a few thrusts.

DESCRIPTION OF IMMATURE STAGES

The egg (Fig. 2 and 3) is subureniform, white with a very thin chorion bearing no sculpturing of and kind. The cephalic end is broader than the caudal. It measures from 0.34 mm. to 0.37 mm. in length by 0 09 mm. to 0.093 mm. in width. The cytoplasm of the egg is granular and homogeneous throughout when freshly laid with a chorion so thin that its presence can be detected only when shrunken.

The ovarian egg (Fig. 4) on dissection of the female is found to differ appreciably in shape from those normally laid. It is somewhat cigar shaped with a curve. When freshly dissected from the ovary, it measures from 0.29 mm. to 0.31 mm. in length by 0.06 mm. to 0.071 mm. in width. The average capacity of the female ovaries appears to be about 30 to 40 eggs which were seen nearly well developed.

First stage larva :—(Fig. 5). The newly hatched larva is a very delicate creature, elongate-oval in general outline slightly tapering towards caudal end and more than twice as long as broad. The head is distinct in the form of a small conical projection followed by 13 body segments though somewhat indistinct. When the larva grows the head becomes proportionately smaller. It is colourless and very active in de Faure's liquid. The head is devoid of antennae. The mouth is ventral and small and consists of a transverse aperture. The mouth parts are poorly developed save the mandibles. The cephalic skeleton is not developed except for the superior mandibular struts and inverted L shaped mandibles and a crescent shaped labrum covering the oral aperture. The integument of the body is smooth and naked. The larva is transparent enough to reveal the main features of internal organs. The muscular foregut is clear sometime after hatching and the stomach (mid-intestine) slowly begins to get, by suction, filled with fat gloubles and surrounding liquid indicating the nature of the food absorbed. No solid food is traceable at this stage. Respiration at this stage is effected continuously by diffusion of oxygen from host blood since no spiracles are developed. Even treacheal trunks are not clear except for a few indistinct fine ones in the middle region. The number of such young larvae found in a single host varies within wide limits. It may vary from 9 to 38, the most usual numbers being 13, 16, 19 and 21, and 33. In a few cases young and more advanced larvae were seen together in the same host. The larvae may be seen floating on blood plasma in any part of the hoemocoele. When these grow in size they naturally get lodged between the body-wall and mid-gut of the host grub. Moulting has not been observed except in the first instar where it occurs within 24 hours. The larval dimensions average as follows :

Length—0.65 mm. Width—0.24 mm. and Head 0.09 mm.

Second stage larva:—(Fig. 6). This stage is in most respects very like the previous one. The shape is slightly altered and has become more oval. The head is more rounded than conical. The mandibles (Fig. 7) are not much modified except that these are a bit stronger. The fore-gut is more clearly defined. The mid-gut has become greatly enlarged and a darker central portion is more noticeable. Neither hind-gut nor anal cleft are traceable. No tracheal system is visible. Even if tracheae are present spiracles are absent. The larva obtains its oxygen dissolved in the blood plasma of the host. This stage ingests only fat globules and hence the fat bodies in the host are considerably reduced by feeding. The late second stage, however, may consume a little of other tissues.

Length averages 1.10 mm. Width averages 0.31 mm. Head averages 0.14 mm.

Third stage larva:—(Fig. 8). The shape has become more elongate and the integument tougher. The mouth parts are more developed and chitinised (Fig. 9). The mandibles are stronger with the struts distinctly developed. The cephalic skeleton is nearly well formed. The parasite commences destruction of internal tissues of host. The mandibles are active in gnawing and scraping of internal tissues of the host which are being fast consumed. The fat body is seldom found in the body cavity of host. The suctorial activity of the pharynx is increasingly visible. The mid-gut contents are much darker. The hind-gut shows traces of development but still not clear. With the host gradually dying and the consequent reduction of oxygen supply, the need for an open tracheal system is apparent. A tracheal system has appeared. Spiracles are developed and clearly visible. With the completion of this stage, parasite is almost getting equipped to migrate outside the host. Dimensions of the parasites are:

Length 2.00 mm. Width 0.45 mm. Head 0.19 mm.

The mature larva:—(Fig. 10). The final-stage larva averages 3.30 mm. in length, 1.00 mm. in width with the head 0 31 mm. It is somewhat fusiform in shape and consists of a head heavily chitinized and 13 body segments. It is whitish in colour save for the dark visible accumulated faecal mass in the gut. The integument is thicker, slightly opaque, smooth and shiny. The body-wall is raised into segmental wavy protrusions. The parasite is most destructive at this stage and is more or less predaceous on all internal host tissues. The host is already dead or dying. The parasite consumes everything except the cuticle and chitinised mouth parts of host. In its stomach are found, on microspopic examination, such host organs as tracheae, alimentary canal and muscles. The feeding continues until it is satiated and the host empties. The anal cleft is visible with hind-gut developed but not connected with mesenteron.

The head is well differentiated into the upper and lower labial lobes with no traces of larval atennae. The cephalic skeleton (Fig. 11) is characteristic and well developed. It comprises the following. Placed transversely and prominently are a pair of sharp, chitinized *mandibles* whose points are dark and more strongly chitinized. Affording articulation to the upper sides of the mandibles are two *superior mandibular struts*. These struts are joined together in the upper clypeal region by a curved semi-circular bar—the *epistoma*. The bracket shaped *pleurostoma* with its two arms connects the superior and inferior mandibular struts which provide sockets for articulation for the condyles. The inferior struts are connected to each other in the labial region of the mouth by a curved compound structure. The *hypostoma* arising at the junction of the inferior mandibular strut and *pleurostoma* is vestigial or absent. The structure known as *tentorium* prominent in Pteromalids is not visible in this Tetrastichinae (Eulophid). The softer parts associated with these are the clypeus and labium, covering the lower aspect, with a salivary duct formed by two smaller ducts opening into the labial region. Besides these, a few papillae or sensoria are also found associated with them. One large pair on either side of epistoma is prominent. Further, muscles for operating these parts are also found for each of these parts such as labrum, labium and mandibles.

The tracheal system of this stage is peripneustic. It consists of two longitudinal trunks and transverse commissures. Nine spiracles are present on the margins of segments. These are joined by spiracular tracheae to trunks (Fig. 12).

As these gregarious larvae consume the host contents and grow, the empty sac-like host is cramped and the cuticle gets swollen with the developing larvae pressing from inside (Fig. 13). The enfeebled cuticle yields and ruptures through pressure and the larvae are exposed. These larvae rest quietly for about 24 hours to 48 hours.

Pre-pupa:—(Fig. 14). The mature larva, after resting for a while, commences its pre-pupal stage by its body being differentiated into three somewhat distinct regions The head which is exactly similar to that of the mature larva with the cephalic structures and mandibles, is followed by a broad thorax and by a still broader and bulbous abdomen. In colour the newly formed pre-pupae is yellowish white. In this stage, the faeces are voided and the body turns uniformly white in colour. The average dimensions are:—

Length 2.9 mm. Width 1.0 mm. Head 0.35 mm.

After about 6 to 8 hours, the cuticle splits resulting in the formation of the pupa.

Pupa:—(Fig. 15). The pupa (averaging 2.1 mm. in length by 0.85 mm. in width) is pale white in colour at first. No cocoon is formed and the pupae lie free inside the host tunnel in the stem. The wings, leg-rudiments, mouth -appendages, eyes, thoracic and abdominal segmentation are well demarcated. It now turns yellowish-brown and darkens in four days. The thorax and head get darkened first followed by that of the abdomen. The extent of pigmentation of the eyes is a reliable index to the age of pupa. In a day after complete darkening, the adult emerges.

EFFECT OF PARASITISM ON THE HOST

The newly parasitised host grubs are at first undistinguishable from others and behave in a normal manner until about the fourth day or the development of the third stage parasite larva. Thev move about and feed in spite of their energy being in a diminishing gradient. The feeding and chewing activities of the early larvae certainly weaken the host although it does not become apparent. The damage to fat body may be seen on dissection of host but is far from being fatal. The feeding of the second stage larva is of greater effect but the host grub is still sufficiently active though weakened. It does not move quite as rapidly as healthy ones. Host grubs having early third stage larvae are distinctly less active and are only able to crawl. Dissection of the host now shows that fat bodies are completely consumed as also parts of internal organs, muscles, and tissues. If the parasite larvae are few in numbers, the internal organs may be intact. Even the alimentary canal may be left yet untouched. By about the close of the third stage, the host body is emaciated though the cuticle appears bloated in some cases. The host grub ceases to crawl with diminishing signs of life until finally life becomes extinct. By the time the larva becomes mature in the fourth stage, nothing is left of the host except the exo-skeleton, head capsule and mouth parts. The pressure exerted b, the growing larvae causes the cuticular bag to rupture and the larvae are exposed in the host tunnel.

SEX RATIO AND PARTHENOGENESIS

Regular records were made of the sex of adults emerged from about 2 hosts besides numerous other observations made on various other occasions. In one instance there were only nine females and no males. In another instance, which is rather exceptional, there were out of 16 adults as many as 10 males. Out of a total of 135 adults (107♀♀ and 28♂♂) the ratio of males to females was 20.7% to 79.3%. It is clear that females predominate in the great majority of observed instances. Since instances have been noted where all adults emerging from a single host happen to be of female sex, it is possible that parthenogenetic reproduction occurs in the species. No complete data are available to demonstrate the phenomenon.

LIFE OF THE ADULT

The adults are not generally long lived. The males are particularly short lived with a maximum of 7 days. The maximum longevity of the females was found to be 30 days with a supply of sugar or honey solution during the cold season—December—January.

INCIDENCE AND SEASONAL HISTORY

The incidence of parasitism displayed such great divergence that no generalisations are possible. Numerous collections and dissections of host grubs have been made from different situations and localities. In some localities groups of plants have been examined with not even a single case of parasitism. In others from certain other situations as high a percentage as 5 to 10 has been recorded. Parasitism was heaviest in some groups of plants found in waste lands in contrast to those near cultivated regions. These observations present some features of ecological interest which, however, remain to be investigated. These are found to be more numerous in collections made from January to April. These occur however, throughout the year though in very small numbers.

SUMMARY

Aprostocetus krishnieri Mani is an important internal parasite of the grubs of *Hypolixus truncatulus* in South India. The rate of parasitism, by rough computation, may vary between 5 to 10% in the height of the season.

The eggs are laid in groups of five or less within the fat bodies in host grubs of about the second instar. There are four larval stages and their morphology is described. The larvae show interesting structural adaptations for their mode of life. The first and second stages derive their sustenance mainly from the surrounding fat body and fluid in the haemocoele cavity of the host. The third and the fourth stage larvae develop strong and sharp mandibles and cephalic skeleton for breaking up the internal organs of the host. The tracheal system is devoid of spiracles until the third stage; spiracles develop at this stage and are connected to the rudimentary stigmatic trunks. The larvae after consuming the entire contents of the host grub get full-grown and emerge out by the rupture of the empty cuticle. Pupation takes place in the host tunnel in the stem. The life cycle covers from 14 to 18 days made up of about half a day in the egg stage, 5 to 7 days in the larval stage, less than half a day as pre-pupa and 6 to 11 days as pupa. The adult lives a maximum of 30 days on sugar or honey solution. It occurs throughout the year but becomes abundant in the season, January to April.

ACKNOWLEDGEMENTS

The writer is indebted to the Government Entomologist, Coimbatore for the facilities afforded for these studies.

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SHORT NOTES AND EXHIBITS

Predators of Grullulus (Gryllus) domesticus L

Two wasps namely *Liris haemorrhoidalis* Fabr. and *Notogonia* Sp. have been observed paralysing the nymphs and adults of the european cricket in the fields and carrying them to their nests for feeding their young ones. Similarly several species of spiders destroy a large number of nymphs and adults of these crickets and effect a considerable check upon the pest at Lyallpur.

Lyallpur K. A. Rahman

Occurrence of Bourbon aspidiotus (*Aspidiotus destructor* Sign.) in the Punjab

This is a very destructive pest of grafted mangoes throughout the mango growing tracts of the Punjab and its distribution continues to be increasing simultaneously with the fruit growing industry in this province The damage starts with the advent of summer season and ultimately it affects the fruit setting adversely. Since the insect feeds on the vital fluids of the infested host the constant drain on young trees may eventually lead to their destruction.

This scale is usually carried from one locality to the other through nursery plants. It is, therefore, suggested that with a view to preventing its dissemination some sort of legislation may be enforced either to eradicate the infested seedlings or disinfect them thoroughly before they are allowed for transportation.

Lyallpur A. R. Ansari

Insect Pests of the Museum

Anthrenus subclaviger Reit; *Tribolium castaneum* Hbst. and a Psocid have been observed doing considerable damage to insect specimens whereas *Anthrenus vorax* Watt. destroys stuffed birds, hoofs and horns in the museum at Lyallpur.

Lyallpur Gurcharan Singh Sohi

Cryptochaetum iceryae Williston (Diptera: Chamaemyidae), A Parasite of *Icerya* Spp.

Cryptochaetum iceryae is well-known as an important parasite of *Icerya purchasi*, the notorious cottony cushion scale. Its original home is believed to be Australia from where Koeble introduced it into America for the control of the cottony cushion scale. It is reported to have successfully established itself especially in the coastal areas of the United States.

Recently I bred a fly, which is most probably *C. iceryae*, from the nymphs of *Icerya pilosa* Green infesting sugarcane leaves at Delhi. The adult fly is a minute metallic blue insect with bright crimson red eyes This is the first record of this parasite from India; the genus *Cryptochaetum* Rondani itself has not been recorded from India before. This find is extremely interesting in that this fly may attack the other species of *Icerya*, including the fluted scale in India.

I. A. R. I.
New Delhi E. S. Menon

On Melcha ornatipennis, A parasite of *Scirpophaga nivella* F., The Top Shoot Borer of Sugarcane.

Melcha ornatipennis Cameron, was first described by Cameron in 1907 from a single male specimen collected by C. T. Bingham from the Salween Valley in Middle Tenasserim, Burma. The parasite has a fairly wide distribution, as the Imperial Pusa collection contains specimens collected from the Punjab, Delhi, United Provinces and Bihar. However, there is no record of it from the Bombay Presidency or south India.

The parasite gets soon reconciled to a life of confinement in the laboratory and it breeds in captivity as freely as it does in the field if suitable hosts are given. A full-fed *Scirpophaga* larva which has cut the exit hole and has covered it with a parchment-like membrane, is in the suitable stage for parasitisation. There is much in the behaviour of this parasite to indicate that it is a specific parasite of this borer, and so far no one has seen it breeding on any other host. Paralysation of the host precedes oviposition and as a rule the parasite lays only one egg on a host but if hosts are scarce, it lays more than one egg on a single host Whatever be the number of eggs that are laid, only one grub attains maturity finally. Insufficiency of food kills the rest. Like many other hymenopterous insects, this parasite is also capable of reproducing parthenogenetically, the progeny, however, of the virgin parasite developing invariably into males. Under laboratory conditions, a female parasite is capable of parasitising 12 to 15 *Scirpophaga* larvae and it takes 17 to 19 days to complete its life cycle, the egg period being 45 hours, larval period 5 to 6 days and the pupal period 10 to 11 days. In winter, the larva enters into hibernation along with the host and pupates early in spring before the overwintering larvae of *S. nivella* enter into pupation. Pupation occurs always in a silken cocoon, the size and texture of which depends on the seasonal conditions. Summer cocoons are thin and white and rather loosely spun around the pupa; winter cocoons are tough and compact.

Adults are very active. The female parasites live longer than the males. Their period of maximum activity in the field is between August and October, which synchronises with the maximum activity of their host and during this period, 35 to 40% of the host-larvae are parasitised. In the first post-winter brood, the females generally are found in excess of males but in the pre-winter or autumn brood, both the sexes are in equal proportion.

The habits and behaviour of the parasite indicate that if properly handled, it is likely to play an important part in the control of the top shoot borer in India.

I. A. R. I., ISHWAR DAYAL MATHUR
New Delhi

Climatology in relation to the Biological Control of Sugarcane Pests.

Several comprehensive notes have already been published by Dr. L. A. Ramdas, showing the effects of climatic factors on plant growth, crop yield and the incidence of pests and diseases. It is an admitted fact that the whole universe is subjected to the weather conditions.

As regards the pests and parasites of sugarcane, it is essential, before undertaking any control measure, to study weather conditions of the locality in which operations are to be started, such as rainfall, air temperature and humidity, soil temperature and moisture, wind velocity and direction, evaporation, cloudiness and other important weather phenomenon. Had it not been for the fluctuating changes of the meteorological conditions from place to place, it would have been very easy to deal with any problem of control from a central place. The climatic factors are to a large extent responsible for a variety of problems that we come across in the various cane growing tracts of India affecting the total out-put of sugarcane. Even if the same variety is grown it may react to the different weather conditions in which it grows in different ways; *viz.*, the same variety may give different results in Delhi, Setabganj and Madras, as regards growth, yield and the pest incidence. For example in Bengal *Argyria tumidicostalis* is very much favoured by high humidity whereas it cannot survive at Delhi and Madras. In Madras and Bengal *A. sticticraspis* and *A. tumidicostalis* respectively, remain active almost throughout the year brood after brood and there is hardly any hibernation at all, whereas at Delhi the activity of stem borers is restricted to certain months of the year when climate favours their existence. In the same way *Pyrilla* in Maharashtra is more or less present throughout the year, but at other places it appears periodically as a pest and that too if climatic factors favour its multiplication. Amongst the stem borers *Sesamia* sp., flourishes only round about Bhopal and Gaya.

So it is quite clear that the entire insect life is closely linked with the climatic factors. Hence it is necessary that in relation to the study of any pest or parasite, not only general but micro-climatic records should also be maintained inside the crop at different levels.

Stem borer control in its egg stage by *Trichogramma* parasites is yet in its experimental stage in this country. But unless general and micro-climatic records are also co-related with the periodical fluctuation in population, we will not be able to say which are the ideal climatic environments for the appearance of the pest and the liberation of the parasites. It also helps us to know the most suitable periods for liberations which may help the survival of the broods of the parasites.

For general and micro-climatic studies, all the instruments should be of standard make, as cheap quality apparatus may give wrong results. Regularity in observations at 7 and 14 hours local time and the maintenance of the instruments according to the instructions are necessary for arriving at useful results.

I. A. R. I.
New Delhi. M. S. ANWAR

Pyrilla control by conservation of egg parasites.

Various control measures such as cultural, mechanical and insecticidal have been attempted with varying degrees of success, to check *Pyrilla*, a major pest of sugarcane all over India. There appears to be no published record of any attempts made to control the pest by means of its egg parasites. The possibilities of the biological method of control were foreseen by Misra and Ram Nath. In 1938 late Dr. J. A. Mulyil tried conservation of *Pyrilla* egg parasites at Meerut; his observations were however of a preliminary nature. In order to come to a definite conclusion regarding the efficacy of the biological method, a well-planned *Pyrilla*, parasite conservation experiment was laid out at Karnal. By conserving the parasites, it is aimed to reduce the population of *Pyrilla* and at the same time, it will increase the population of the local egg parasites. This will be carried out by collecting all *Pyrilla* egg-masses (whether parasitised or unparasitised) from experimental plots and then putting them in suitable wooden cages with wire gauze sides. The mesh (30 to 40 per linear inch) of the gauze would allow the parasites to escape to do their beneficient work, but not the nymphs that hatch out of the unparasitised eggs. The nymphs for want of food, would perish in the cage. Thus, in this simple experiment, the principles of mechanical as well as biological methods of control are harmoniously incorporated. The cages are distributed in the field to ensure the even distribution of the parasites at the rate of 21 cages per plot of ⅛ acre. The cages are emptied and refilled every month; whilst observations on 2% basis are carried out fortnightly. Up till June 1943, the plots were free from *Pyrilla* as well as its egg parasites. With the commencement of the monsoon in right earnest in July, and the prevailing hot humid air, the host and parasites have begun to make their appearances in large number and the conservation of the parasites is in progress.

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I. A. R. I.
New Delhi

E. J. VEVAI.

The cotton flower weevil - *Amorphoidea arcuata* M.

This weevil has been recorded previously by Ramakrishna Ayyar in 1932 as feeding inside flowers of cotton. It is not generally considered a serious pest. In 1940 the insect was found breeding inside tender bolls, the grubs feeding from the tip. The infestation by this weevil was however on the increase in 1941. As high as 35·2% of the shed tender bolls were found attacked by the grubs early in February and thereafter there was a noticeable fall in incidence to 1 3% by the first week of March.

Coimbatore

M. C. CHERIAN and V. MARGABANDHU.

Selepa docilis Butl., and its parasite *Euplectrus euplexiae* Roh.

Selepa docilis Butl., belongs to the family Noctuidae and is a minor pest of brinjal. Moths begin to lay eggs the day after emergence. The eggs are pyramidal with ridges all round and pale or light yellow. They measure 0·5 mm. across. Eggs are laid in small groups, generally 4 to 12 in number, on the shoots and upper surface of leaves. A maximum of 148 eggs was laid by a single female during her life time. In three other cases 107, 112 and 112 eggs were laid. The egg period is 3 days. The just hatched larva is transparent with ridges all over the body and measures 1 mm. in length. The young caterpillars, for the first few days, feed together in a cluster. They are generally found on the upper side of the leaves. Moulting occurs four times. The full grown larva is light green on the sides with reddish orange bands on the dorsal surface. Blotches of long white hairs are borne on the lateral side in each segment. The dorsal surface on every segment also bears short hairs. The dorsal surface of 2nd and 3rd thoracic segments and the 2nd and 9th abdominal segments is black in color. The head is pale creamy. The full grown caterpillar measures about 15 mm. and feeds very voraciously on the leaves, leaving only the mid ribs and veins. The larval period is 7 to 10 days. A day prior to pupation the larva slackens feeding and is somewhat inactive. It selects a suitable situation, generally on the stem or midrib on the under surface of the leaf and begins spinning cocoon. The cocoon is dirty white in color and measures about 10 mm. long.

The pupa inside the cocoon measures about 10 mm. long The pupal period is 7 to 11 days. The total life cycle from the egg to the adult is 18 to 24 days. When fed with honey solution, under laboratory conditions, a male lived upto 8 days while a female lived for 11 days.

The parasite—*Euplectrus euplexiae* Roh., belongs to the family Eulophidae, sub-family Elachertinae. The thoracic segments of both male and female are black while those of the abdomen are yellow in colour. The head of the female is black, that of the male yellow. Eggs are translucent, elongate and cylindrical and measure 0·25 mm. long. They are laid singly on the body of the host caterpillar, generally one egg on each segment. The parasite spreads out a gummy fluid on the body of the host and sticks the egg on it. The larval stage liked by the wasp is fairly grown up caterpillars—4 to 5 days old. A maximum of 38 eggs was laid by a single female distributed over 7 caterpillars on different dates during her lifetime while three others laid 30, 29 and 23 eggs respectively. Eggs hatch in less than 24 hours. The just hatched grubs are transparent. As they grow in size they are light yellowish. The grubs throughout their active larval life do not move about but, remaining where they are, completely suck out the body contents, leaving only the empty skin. Full grown grubs are light green or bluish in colour and measure 1 mm. long. At this stage, they descend to the ventral side of their host and arrange themselves in a row surrounded by sparse dirty white hairs They form into pupae the next day. The pupae are firmly attached to the host skin above. The larval period is 3-4 days. The pupae are light red or brown in colour and measure 1 mm. long. The pupal period is 4 days. The total life cycle from egg to adult varies from 8-10 days—the egg, larval and pupal periods being less than one day, 3-4 days and 4-5 days respectively. When fed with honey solution a male lived 40 days and a female 19 days.

Coimbatore. M. C. Cherian and B. Rangiah Pillai

Grammodes stolida Fabr.—A pest of daincha (*Sesbania aculeata*)

Grammodes stolida Fabr. (Noctuidae) was found doing severe damage to *daincha* in the Central Farm, Coimbatore, in November to December, 1935. The damage was so severe that most of the plants were defoliated. Under laboratory conditions the pest was found to feed on *agathi* (*Sesbania grandiflora*). The life history of the pest worked on this plant is given below:—

The moths are of moderate size, 30 to 40 mm. in length and grey in colour. The forewing has a white marginal line while the hind wing has a white band. The moths pair on the second day after emergence. The maximum number of eggs laid was 199 and the minimum 56. The maximum longevity of the moths was 8 days. Eggs are laid singly on the shoots of the food plant. They are dull green in colour and ribbed. The egg stage is of 2 to 4 days. The newly hatched larva is pale green and 4 mm in length The head and legs are brown. On the dorsal surface of the thoracic segments there are three black dots arranged on either side. Four reddish lines are seen on the dorsal surface of the abdomen. After the first moult the caterpillar is greyish and about 12 mm. long. There are three reddish lines along the dorsal surface of the thorax and abdomen. On the second abdominal segment there are two black dots one on either side. There are also two smaller dots on the tenth segment. After the third moult there is no change in colour and the caterpillar is about 35 mm. long. The next day after moulting it stops feeding. It takes three days to spin its cocoon completely and to transform into a pupa. The larval period is 15 to 22 days. The pupa is chestnut brown and 15 mm. long. It is enclosed in a cocoon of light thin yellow silk within folds of leaves. In a few cases the caterpillars pupate in earthen cocoons in the soil. The pupal period is about 10 to 12 days. In three instances it was found to be 107, 101 and 131 days

Coimbatore M. C. CHERIAN and C. V. SUNDARAM

Acorus calamus—the sweet-flag—a new indigenous insecticide for the household.

A safe and promising vegetable insecticide that has yielded encouraging results at Coimbatore is the common plant, *Acorus calamus*—known as sweet-flag in English and *Vasambu* in Tamil. The rhizome of this plant which grows wild in places like the marshy lake side in Ootacamund, has been long in use in Indian pharmacopoeia and its insecticidal properties have also been talked of for a long time. On actual experiment the rhizomes dried and powdered have given very encouraging results against such household insects as the bird-lice, on fowl, bed bug, clothes moth etc. Dusting of the powder on fowls infected with bird lice killed a large proportion of them in the course of the night and the next morning there were no living lice on the birds so treated. When flannel was dusted over with the powder and enclosed with a number of clothes moths, the latter all died in the course of a few hours and there was no breeding of the insect in the flannel, while in the case of the control where an untreated piece of flannel was similarly enclosed with equal number of clothes moths, the moths lived for a few days, laid eggs on the flannel and the caterpillars hatched and fed on it. The powder when dusted on bed bugs killed them in the course of 2 or 3 days. It had no effect on the eggs but the nymphs that hatched out from the eggs died in the course of a few hours. The use of this substance in the control of weevils in stored grains and crop pests is being tried on a large scale with very hopeful results.

Coimbatore T. V. SUBRAHMANYAM

Two interesting cases of migration of insects noted at Coimbatore.

I. Swarming and migration of insects are common in cases like butterflies, grass-hoppers or locusts, bees etc., when the insects concerned leave their homes in large numbers and go and settle down in far off places evidently in search of better places for food or protection. But it is rather a rare phenomenon among beetles and especially so among weevils, where the individuals are shy creatures and though provided with well developed wings rarely fly long distances. Hence it was very interesting to note this habit once in the case of the amaranthus weevil—*Lixus brachyrhinus*. One fine morning at about 10 o'clock, a buzzing noise was heard over my head in front of my bungalow from a big swarm of small insects travelling pretty fast in a south-westerly direction along a strong wind. I thought it might be a case of a swarm of bees from the apiary shed nearby. But on catching a few of the insects it was found that the swarm was one of the amaranthus weevil. They were moving so fast that by the time I brought out a net to catch more of these, they had gone a long way off.

II. Another instance of migration was that of two butterflies—*Danais limniaceae* and *Euploea core*. One evening at about 5-30 p.m. when the weather was cloudy and chilly, large swarms of these two species of butterflies were seen hovering round *Peltophorum* flowers along the avenue on the estate. The two species appeared together more or less in the proportion of 2 : 5.

Next morning at about 7 or 8 a.m. when the weather was again similar, these were again found to fly in continuous streams in a south-westerly direction towards the Marudamalai Hills along a gentle wind blowing in that direction. They were flying not very high—about 4-10 feet from the ground, passing over and between plants, shrubs and other vegetation, but were never seen to halt on any of these even for a while and passed off beyond the estate. The stream stopped by about 10-30 a.m. when the sun got high but started again the next morning under similar conditions. The numbers of butterflies decreased on the second day considerably and only very few were found on the third day and none afterwards. From where they came and where they went is not known, except that they entered the estate in north-east corner and left it at the south-west corner near the Millet Station. The peculiar feature is that the migration was only when the weather was cloudy and that these two species were found mixed up in their flight.

Coimbatore T. V. SUBRAHMANYAM

Longevity and flight range of the Indian honey bee *APIS INDICA*

To study the longevity of the Indian honey bee, newly emerged bees were marked and introduced immediately into a normal working colony housed in an observation hive. Silver gilt powder mixed with spirit gum was used for marking the bees. Bees were marked on the thorax with a fine brush. The material easily dried leaving a white lustrous spot on the thorax which remained throughout the life of the bee and never produced any reaction to impair the normal activity of the bee. White enamel paint diluted with turpentine was found equally effective The behaviour of the marked bees was daily noted. The periods of longevity noted for three cases were 47, 49 and 49 days for bees which emerged on 12-3-42, 11-6-42 and 28-8-1942 respectively. In the first observation marked bees were seen leaving the hive for out-door activities on the 16th day from the date of their emergence. In the second and third observations they began going out even on the 12th day. Studies on the longevity of the bees in different months are in progress.

The same system of marking was adopted for the study of flight range of bees. As many as 15,000 bees of all ages, irrespective of the fact whether they are nurses or foragers, were marked on a particular date. All crops and wild plants in flower at various distances from the hive were daily examined for marked bees. The period of observation was during the month of July when the south-west monsoon and consequent high wind velocity prevailed. It was found that bees were collecting pollen from *Pennisetum typhoideum* three furlongs from the hive. Further observations are in progress.

Coimbatore M. C. CHERIAN

RECENT RESEARCH

The Role of Integument in the Efficacy of Contact Insecticides

There is a considerable amount of literature on the effect of contact insecticides on various pests. It has been shown that the rate of entry of insecticides is slower in older insects, presumably on account of their cuticle being thick. Some authors have shown that the inter-segmental regions of the thorax and abdomen are more permeable to insecticides than the highly chitinized regions. Some believe that the penetration is chiefly through the thin walls of the pores at the base of the sensory hairs. Some attribute this to the hair sockets, dermal sense organs, pore-canals, etc. etc. It appears that the phenomenon of penetration of insecticides is very complex and is very much influenced by the physico-chemical nature of the cuticle or of the lipoid layer because it has been observed that in the case of some insects which have even thinner cuticle, the penetration is more than in the case of those which have thicker cuticle. Dr. Wigglesworth has recently studied the penetration of pyrethrum extract in the integument of the bug *Rhodinus* (*Bull. Ent. Res.*, **33** (3) : 205-19). He has shown that the stretched cuticle is more permeable to pyrethrum than the unstretched cuticle of equal thickness presumably because of the enlargement of the pore-canals on stretching. Further it appears that the entry occurs through the general cuticle and epidermis in recently formed or stretched cuticle, and in the older or less stretched nymphs of *Rhodinus* it takes place chiefly around the bristles. On the other hand in the case of older adults of this bug absorption takes place by dermal glands Thus it is evident that there are great differences with regard to absorption of insecticides in different insects and in different parts of the same insect and during different stages of growth in the case of the same insect species.

It has been also shown that entry is more rapid in lighter than in heavy petroleum oils and it is much accelerated if the cuticle is first treated with petroleum ether. Entry is very slow with vegetable oils. There are great individual variations due chiefly to the thickness of the endocuticle which in turn is determined by the size of the meal taken before moulting, the age and amount of food taken after moulting, etc. The rapid entry of pyrethrum and light oils is attributed to latter's property of dissolving lipoid layer.

The paper clearly brings out the fact that while testing insecticides one has to be very careful in the selection of the material so that insect of the same stage of growth and approximately having the same previous history with regard to food etc. form basis for experimental work.

H. S. P.

The requirements of parasites far more than hosts

In a thoughtful discussion Dr. G. N. Wolcott of the Agricultural Research Station, Puerto Rico, (Science **31**, 317-318, 1942) draws the attention of applied entomologists to the complexity of the problem of parasitic introduction for the control of injurious insects. He rightly complains that entomologists have attached far more importance than warranted on the "Beneficial parasitic stage of the parasite" and neglected a single or combination of factors that govern the survival of the parasites in their non-parasitic stage. This complacent attitude of the entomologists towards the whole problem can be attributed to the spectacular success achieved in the case of the introduction of Australian

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ERRATA.

Corrections are limited to the more important errors.

Page	13 line 10 from top	for	*Brumus saturalis*	read	*Brumus suturalis.*
	13 „ 11 „ „	„	*Synia millanaria*	„	*Synia melanaria.*
	21 reference 11	for	Lacodair	„	Lacordaire.
	21 „ 15	„	McIndo	„	McIndoo.
	21 „ 15	„	*Ann. Ent.* Soc. *Amer.*, 2	„	*Ann .Ent.* Soc. *Amer.*, 9.
	24 line 18 from bottom	for	PACHYTROCINAE	„	PACHYTROCTINAE.
	25 „ 17 „ „	„	*Peritroctis*	„	*Peritroctes.*
	25 „ 14 „ „	Insert stop after Liposcellidae and delete the [illegible] of the paragraph.			
	34 „ 18 „ top	for	*laterielli*	read	*latreillei.*
	44 footnote	for	Rie.	„	Rec.
	66 reference 11	for	Beige	„	Belge.
	66 „ 19	„	Secripalp	„	Securipalp.
	66 „ 23	„	Strauhal	„	Strouhal.
	66 „ 25	„	Dentsche	„	Deutsche.
	103 line 7 from bottom	for	eaudal	„	caudal.
	114 „ 19 „ „	„	Month- cone	„	Mouth-cone.
	131 „ 9 „ „	„	Fuemekiola	„	Fulmekiola.
	155 „ 4 „ „	„	memonotum	„	mesonotum.
	182 „ 1 „ „	„	vehicles	„	vesicles.
	207 „ 1 „ „	„	Lagersromia	„	Lagerstroemia.
	228 „ 15 „ „	„	and	„	any.

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